THE RELATIONSHIP BETWEEN ADHERENCE BEHAVIORS AND GLYCEMIC CONTROL IN CHILDHOOD DIABETES

BY

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This study was designed to investigate the following questions: 1) do children's diabetes management behaviors change at summer camp; 2) does attendance at summer camp affect diabetic children's glycemic control; 3) if there are changes at camp, are they maintained at home; 4) is there a relationship between adherence behavior and glycemic control. Sixty-four 7- to 12.6-year old youngsters with diabetes were followed before, during, and after attending a 2-week summer camp. Both their diabetes management behaviors and their glycemic control were monitored.

Children's diabetes management behaviors (i.e., injection regularity, injection interval, calories consumed, eating frequency, exercise duration, exercise type, exercise frequency, and glucose testing frequency) changed significantly while they attended summer camp. There was also a

change in children's level of glycemic control as measured by glycosylated serum protein levels. However, children were in poorer glycemic control at the end of camp than at the beginning. None of these camp-related changes were maintained once the youngsters returned home. No clear relationship between adherence behaviors during camp and control could be established. However, post-camp metabolic control was predicted by an interaction between change in insulin dose (pre- to post-camp) and injection adherence behaviors. Youngsters who had large increases in insulin dose exhibited a deterioration in metabolic control when they were more adherent. Youngsters who had large decreases in insulin dose exhibited the opposite relationship: better adherence was associated with better control. Further inspection of this statistically significant interaction indicated that pre- post-camp change in insulin dose appeared to be initiated during camp. Camp related insulin dose changes were maintained or enhanced once the children went home. The group of children whose insulin was increased during camp, were given further increases in insulin dose once they returned home and may have been experiencing the Somogyi phenomenon (rebounding) after camp as a consequence of excessive increments in their insulin dose. Home physicians, appeared to have used insulin adjustments made during camp as a model of treatment and continued the trend initiated by the camp physicians. It

appears that high levels of adherence with inappropriate insulin dose prescriptions can lead to poorer control.

INTRODUCTION

Insulin dependent diabetes mellitus (IDDM) is a chronic illness, the result of insufficient insulin production by the pancreas. Onset occurs before age 30--most frequently between the ages of 8 and 12 years--although it can occur at any time from birth to adulthood (Blevins, 1979).

Under normal circumstances, insulin is secreted directly into the blood-stream by the Islets of Langerhans in the pancreas. This hormone plays a vital role in the metabolism of food since it facilitates the movement of glucose from the bloodstream into muscle and fat tissue for energy. Glucose that is not used for energy is then directed into storage (primarily into the liver) in the form of glycogen and/or fat. Fat is an additional source of energy which does not require insulin to be converted. However, the energy expended in its production is considerable, leaving a negligible amount for functional use. Normally, the pancreas secretes insulin at rates that maintain glucose levels in the bloodstream within a narrow range. In youngsters with IDDM, the pancreas cannot perform this function and glucose levels build up.

The absence of insulin prevents glucose usage, fat is broken down and glucose levels remain high. The liver

converts some of the fat into ketones, which increase in the blood and, at high levels, spill into the urine. In addition, when the blood passes through the kidney, glucose is filtered out and, at high levels, the extra glucose spills over into the urine. The kidney attempts to filter out the excess glucose and ketones from the blood in order to maintain acid alkaline (Ph) levels within normal limits. This results in increased urination and increased thirst. However, the kidney can not keep up this level of activity. Unchecked, ketones and acids build up in the blood and the child develops diabetic ketoacidosis--a serious condition requiring hospitalization. Furthermore, the loss of urine water and the use of body fat for energy produce weight loss (Travis, 1969). If this condition is untreated, coma and death can result.

Presenting symptoms of IDDM include polyuria, polydipsia, polyphagia, and weight loss. There is often a high prevalence of infections. More subtle signs of the disorder include pruritus (severe and protracted itching of the skin), enuresis (bedwetting), vulvitis, irascible disposition, lassitude, and abrupt onset of visual difficulties (Sussman, 1971). As yet, there is no cure for this disease.

The treatment of IDDM consists of the following:

1) Daily insulin injections--A child with IDDM injects insulin at least once and as many as four times daily for the rest of his/her life

because the pancreas does not resume insulin production.

2) Controlled diet--Food intake must be adjusted for content and synchronized with the injections and exercise for optimal benefit. The youngster must eat three meals a day as well as one to three snacks per day, preferably at regular intervals. Low fat nutrition is encouraged and concentrated sweets are to be avoided.

3) Regular exercise--An exercise regimen is important for improving cardiovascular functioning which facilitates insulin circulation.

4) Glucose testing--Close monitoring of glycemic control (approximately four times per day preferably before meals) is recommended so that meals, snacks, and exercise can be appropriately adjusted. In addition, this information is necessary for the physician to make appropriate changes in regimen recommendations.

The various components of the regimen are tailored to the needs of each individual youngster. The goal of treatment is to maintain blood glucose levels within a reasonable range in order to promote normal growth and

development and to prevent complications. With growing youngsters, this task is particularly difficult since their nutritional and insulin requirements are changing as they grow and injections administered once or twice a day cannot imitate the synchronous pancreatic action of nondiabetic individuals (Guthrie and Guthrie, 1977).

Complications associated with IDDM can be divided into three categories: short-term, intermediate, and long-term.

1) Short-term (acute) consequences include diabetic ketoacidosis (DKA), hypoglycemia and hyperglycemia. Diabetic ketoacidosis can be precipitated by an infection although stress or insufficient insulin can also be a precipitant. Symptoms include rapid respiration, polydipsia, polyuria, vomiting and nausea. Hypoglycemia (insulin reaction) can be caused by overdoses of insulin, its improper distribution, inadequate intake (or delayed absorption) of food, or too much exercise without a concurrent adjustment of the food intake (Guthrie and Guthrie, 1977). Increased perspiration, confusion, irritability and inappropriate behavior are common symptoms (Sussman, 1971). Hyperglycemia may result from too little insulin, eating improperly, decreased exercise (without concomitant decreased food intake),

emotional stress, and infection. The most frequent symptoms are weakness, increased thirst, frequent urination, dry mouth, decreased appetite or polyphagia, nausea and vomiting, abdominal pain, coma, and acetone breath which occurs when ketone levels rise in advanced stages. These acute consequences are characteristic of youngsters in poor control (Guthrie and Guthrie, 1977).

2) Intermediate consequences include delayed growth and development, frequent infections, and psychosocial problems. Delayed growth and development in IDDM youngsters is not uncommon and has been found to correlate most clearly with those children in poor control (Guthrie and Guthrie, 1977). Various kinds of infections are also common in IDDM children. Clinical observations and research suggest that these are also more common in patients in poor diabetes control (Guthrie and Guthrie, 1977). Psychological problems are associated with poor control although the nature of the relationship between psychological problems and health status in youngsters with diabetes is not entirely clear (Johnson, 1985).

3) Long-term (chronic) consequences of the disease include retinopathy and nephropathy. Retinopathy is characterized by the formation of new capillaries and duplication of small veins, retinal detachment, preretinal and vitreous hemorrhage, and fibrosis. Blindness may be the result (Sussman, 1971). Nephropathy (renal disease) is the leading cause of death among people with IDDM (Blevins, 1979). Complications occur 15-20 years after diabetes onset. Scientific data suggest that these diseases may be preventable if the patient's diabetes is maintained in good control (Guthrie and Guthrie, 1977).

Clearly, metabolic control, or lack thereof, is implicated in all three categories of complications both directly and indirectly. Although evidence that complications occur more frequently among patients in poor control is mounting (Rifkin, 1978; Maxwell, Luft, Clark, and Vinicor, 1982; Unger,1982; Johnson, 1984), it is difficult to properly evaluate this literature since the definition of "control" is so loosely posited and varies from investigator to investigator. Moreover, a definitive link between adherence to prescribed regimen (i.e. behavior) and control has yet to be established.

Studies in this area are few and present numerous methodological problems. For example, control and compliance are often confused as when hemoglobin A1c (HbA_1c), a metabolic indicator of glycemic control, is taken to represent compliance. In some cases, although both constructs are treated separately, the same person judges both, introducing the possibility of a spurious association between the two (i.e., the rater may believe compliance and control are related and judge them accordingly).

The few studies in the area can be divided into two categories. The first category is composed of correlational studies which are concerned with establishing associations between compliance behaviors and control. One such study by Rainwater, Jackson and Burns (1982) tried to assess the relationship between psychological variables, metabolic control, and behavioral measures using 115 children between 8 and 17 years and their mothers. Their most noteworthy finding was that Mother's Health Locus of Control (MHLC) was significantly correlated with behavioral and metabolic measures suggesting that mothers who scored external tended to have better controlled children. That is, MHLC correlated significantly $r=-.58$, $p< .01$, with total amount of sugar spilled in a 24-hour urine sample collected from the patient, the number of patient hospitalizations in the past year, $-.42$, ($p<.01$), the number of insulin reactions experienced by the patient in the past month $r=.36$ ($p<.01$), and the number of hours the patient exercised per week

during the past 3 months r=.35 ($p<.01$). However, HbA_1c did not correlate significantly with MHLC or Mother's General Locus of Control. Further, there appeared to be no significant relationship between the author's diabetes control indices (such as 24-hour urine, number of hospitalizations, number of reactions, hours of exercise and HbA_1c) and the child's self-esteem (measured by the Piers-Harris Inventory) or with the child's life change scores (measured with the Coddington Scale for Life Events).

This study claimed to have used both behavioral (defined by the authors as the number of hours exercised per week, number of diabetes related hospitalizations in the past year, and number of insulin reactions in the past month, and number of times acetone was noted in the urine in the past month) and metabolic (hemoglobin A_1c, triglycerides, cholesterol, fasting blood sugar, and total amount of sugar spilled in the urine in a 24-hour period) measures which the authors presumed to reflect diabetes control. Glycosylated hemoglobin (HbA_1c) is now widely accepted as the single most reliable and adequate measure of glycemic control. The authors' use of 24-hour urine as an index of control is problematic for two reasons. Valid 24-hour urines are difficult to collect even under controlled conditions such as hospitals. In our experience, only 20-25% of all specimens solicited and collected were complete collections. Glycosylated hemoglobin (HbA_1c) values are a more widely accepted measure of control than

24-hour urines and provide a more stable measure of control over the preceding 3 months rather than just 24 hours. Rainwater et al. did not report whether the 24-hour specimens in their study were valid. Even if the 24-hour collection was valid, it indirectly represents the youngster's metabolic control for a relatively brief period of time. Since no relationship was shown between MHLC and HbA_1c, the most reliable indicator of metabolic control over the past 3 months, the relationship between MHLC and the 24-hour collection data is difficult to interpret (i.e., why would such a relationship exist for one measure of diabetes control but not another?). Furthermore, the study did not directly assess adherence behaviors. Rather, behavioral measures, as defined by the authors, consisted of report by family of the number of diabetes related hospitalizations in the past year, average number of hours of exercise per week over the past 3 months, number of insulin reactions in the past month, and number of times acetone was noted in the urine in the past month, thereby confusing adherence behaviors with metabolic indicators and other sequelae of poor control.

In another correlational study, LaGreca et al. (1982) examined the relationship between metabolic control as measured by hemoglobin A_1 and different aspects of diabetes care such as degree of responsibility taken by the child, level of knowledge, and degree of compliance as rated by physicians following routine appointments with 40 IDDM

youngsters. Results of this study indicate that for preadolescents there was no relationship between physicians compliance ratings and metabolic control. For adolescents the best predictor of control was the child's overall level of compliance with the treatment regimen, especially with eating regular snacks and carrying sugar for emergencies. However, their findings suggest that regardless of compliance ratings, the more responsibility assumed by the youngster, the poorer their control.

It should be noted that the physician's four-point rating of compliance was based on patient report (testing, charting, administering insulin, eating proper foods, eating regular snacks, carrying quick-acting sugar, and taking sugar to treat reactions) as well as on whether the child kept appointments. The reliability of these ratings was not tested and it is unclear whether the physician's rating may have been influenced by the patient's current level of metabolic control. Furthermore, no information was provided about the relative importance of any one aspect of the regimen.

McCulloch et al. (1983) correlated dietary behaviors such as accuracy of measuring carbohydrates and maintaining consistent and regular eating patterns with HbA_1 in adult diabetics who kept 7-day diaries. Results indicated better glycemic control in those persons who were more precise in their measurements and compliant in the regularity of their meals. There was, however, no attempt made to corroborate

the patients' self-reports, and nondietary aspects of the treatment regimen were not studied.

One study that has attempted to address the more global versus specific nature of the relationship between adherence and metabolic control was conducted by Schafer, Glasgow, McCaul, and Dreher (1983). Their 34 subjects were 12 to 14-year-olds with IDDM who completed questionnaires dealing with regimen adherence for the past week as well as psychosocial measures dealing with diabetes-specific family behaviors, barriers to adherence, and family interactions. They found that compliance was a highly specific construct; the degree of adherence to one aspect of the IDDM regimen was not related to adherence to the other aspects of the regimen. Using multiple correlations, they also found that glycosylated hemoglobin levels could be predicted from a combination of three adherence measures (i.e., the extent to which one's diet was followed, reported care measuring insulin doses, and number of daily glucose tests). Unfortunately, the reliability of the self-report compliance measures was not assessed, nor was there any attempt to verify their reports by actual measurement of home behaviors or by corroboration by significant others. In addition, the use of multiple regression with such a small sample and such a large number of variables is likely to severely overestimate the strength of the resultant R^2.

In a more thorough study by some of the same investigators (Glasgow, McCaul, and Schafer, 1987), these same

issues were addressed with 93 adult IDDM outpatients. Similar to the Schafer et al.(1983) study, this investigation explored adherence to various aspects of the diabetes care regimen, the congruity of adherence of the different behavioral components, and the relationship between adherence and glycemic control as measured by glycosylated hemoglobin. Subjects participated in three home interviews during a 1 week period, completed psychosocial measures, collected self-care measures on injections, glucose testing, diet and physical activity. The entire procedure was repeated for a subsample at two months and for the entire sample at six months. Self-report information was organized into five categories of adherence: insulin injections, glucose testing, diet level, dietary adherence, and physical activity. Glycemic control was measured with glycosylated hemoglobin and percent negative glucose tests (both urine and blood). Each adherence measure was compared to patient report of regimen prescriptions. Their results indicated that compliance was better for taking medication and for glucose testing than for behaviors which required major adjustments in routine (e.g., diet and exercise); adherence with one component of the regimen did not necessarily correlate with adherence to other regimen tasks. Compliance behaviors were not stable over time although glycemic control was relatively stable; no clear relationship between adherence and glycemic control was established through either bivariate or multivariate analyses. Although this

study is an improvement over most correlational studies, there are some basic weaknesses. For example, no attempt was made to verify actual diabetologists' prescriptions--rather patient report of physician prescriptions were used and comparisons were made to the self-reports or in some instances to absolute levels of behaviors (although the authors do not define "absolute levels," these are presumably meant to be ideal levels). Similarly, no attempt was made to corroborate any of the self-reports of adherence. Moreover, in calculating dietary compliance, only evening meals were used.

Intervention studies comprise the second category of investigations in the area of compliance and control. These studies concentrate on increasing compliance, assuming that lack of adherence to the medical regimen can result in serious diabetic complications. However, a number of these studies seek to modify adherence but do not include measures of control. In one such study Gross (1982) conducted a multiple baseline intervention with four IDDM boys aged 10-12 years to determine the utility of self-management behaviors. The youngsters were selected based on parent report that they failed to reliably perform their urine tests the recommended four times per day. The boys received six 1-hour long sessions (one per week) which consisted of written lessons, discussions, modeling and role-playing. In addition, the children were assigned a self-management project which included collecting baseline data on the

frequency of their urine testing which was arbitrarily designated by the investigator as the target behavior. The youngsters chose rewards and self-delivered them contingent on performing the target behavior and graphed their performance. During the final phase, the subjects were taught negotiating and contracting skills and in a meeting with the experimenter, the child, and his parents a contract was arbitrated. All contracts involved parental reinforcement for continuation of self-management of urine testing. Reliability data were collected by parents counting the number of test tablets used on 1 day each week when the child was not at home. The children were aware that the parents would be checking but did not know when. No attempt was made to monitor the accuracy of the children's urine testing. Reliability was based on dividing the number of agreements of parent and child report by agreement plus disagreement and multiplying the quotient by 100. Reliability averaged 80%. No data were reported on the rate of compliance with the self-reward regimen. Pre- and post-training tests on the principles and procedures of behavior modification were conducted and 2- and 8-week follow-up data were also collected. Children improved their rate of urine testing from 9% to 74% of the time during the self-management condition and at the 2-week follow-up. However, at the 8-week follow-up, two of the four families had discontinued with the contract and those children's behavior had returned to baseline levels.

Only one of the many necessary diabetes management behaviors was targeted in this study and no attempt was made to determine whether increasing the frequency of urine testing had an effect on children's level of control.

An intervention study by Epstein et al. (1981) employed parent training procedures. Twenty families were assigned to one of three groups in a multiple baseline design. Parents were instructed to use a point system and praise for their youngsters' compliance with urine testing. Both self-report (daily urine test results and adherence to urine testing regimen) and biochemical measures (insulin dosage, HbA_1, plasma glucose, serum lipids) were used to assess effects of the intervention. Epstein et al. went to considerable lengths to determine the reliability of the children's recordings (although only negative urine data were used for analyses) by asking parents to test four urines per week on a schedule determined by the experimenters and without knowledge of the child's values. Reliability was assessed for 91% of the treatment weeks and parents and children agreed on the glucose concentration within a one measurement interval range on each of the four reliability tests during 83% of the weeks. Exact parent/child agreement on the urine tests was not reported. The reliability/validity of reported urine testing frequency was measured by including predetermined quantities of inert, placebo Clinitest tablets in each bottle. Parents were informed about the correct number of placebos. At the end

of each week, parents were instructed to test the remaining tablets in each bottle, and add the number they found to the number the child reported finding. Comparisons of this number to the actual number provided the measure of the child's adherence to the regimen for that week. Parents and children agreed on the number of marked items during 76% of the weeks. Results showed a significant increase in the number of tests performed and in the percent of urine tests that were negative for glucose, although other metabolic indices of diabetic control did not show improvement. Epstein et al. concluded that behavioral techniques appear useful for improving behavioral adherence to diabetes regimen. However, in this study, increasing the number of urine tests that were negative for glucose was not associated with improvement in other measures of diabetic control.

Kaplan, Chadwick and Schimmel (1985) randomly assigned 21 IDDM teenagers between 13 and 18 from middle class backgrounds to either a daily social learning group or a medical facts learning group when they entered a 3 week summer program. The social learning group identified social situations in which peer influence might prevent adherence to diabetes regimen and as a group suggested appropriate responses. Rehearsal exercises enacting problem situations and their solutions were ultimately videotaped and then filmed in a television studio. Guided practice with reinforcement was used to develop their social skills. The control group spent the same amount of time discussing

diabetes relevant medical information. These discussions were videotaped and then filmed. Hemoglobin A_1 was drawn during the program to measure metabolic control before the program and at a 4-month reunion to measure metabolic control since the program.

The groups were equivalent at the beginning of the program. Hemoglobin A_1 values at the reunion (obtained for 82% of those who provided an original sample) showed a slight increase in values for the control group and a contrasting decrease for the experimental group. Furthermore, the authors found a substantial correlation ($r=-.78$) between self-reported self-care and diabetes control as measured with HbA_1 values. This study is an improvement over earlier research in that intervention was directed at many aspects of the treatment regimen instead of urine testing alone. Furthermore, correlations between adherence behaviors and control were provided.

However, the study's experimental and control groups were small and restricted to white middle class adolescents. The reliability of the self-report measures of compliance was not assessed nor were parents surveyed to corroborate the youngsters' report. Before treatment, the experimental group was in slightly better diabetes control than the control group (although the difference was not statistically significant). At post-treatment, it was unclear whether the slight improvement of the experimental group and the slight deterioration of the controls was clearly related to the

study's intervention or was a natural continuation of each group's pretreatment metabolic condition. Pre/post- changes in diabetic control were not significant and there was no assessment of and therefore no evidence that one group's compliance was better than the other group's at post-treatment. Consequently, the only evidence clearly in favor of the experimental group was the post-treatment difference in HbA_1. Certainly, a replication of the study's findings is needed if we are to have confidence that the post-treatment HbA_1 differences were, in fact, due to the intervention employed.

Schafer, Glasgow, and McCaul (1982) designed a multiple baseline approach to assess the effectiveness of goal setting and behavioral contracting to increase adherence and control in three adolescents with IDDM. A self-monitoring program of 1 week, introduced before goal setting, constituted the baseline phase. Contracting was introduced only if 90% compliance was not achieved. Compliance was assessed by subjects records of relevant target activity such as time, duration, etc. Reliability checks were made periodically by mothers' independent monitoring. Diabetic control was assessed with urine glucose tests performed and recorded daily by subjects. Reliability checks were conducted by having mothers spot-check the urine tests. Two hour postprandial blood glucose levels were determined, and 24-hour urine glucose was collected at pretest, posttest, and followup. Two of the subjects showed improvements in

compliance and control. The third was essentially unaffected by the treatment.

Unfortunately, as mentioned above, the use of 24 hour urines as indices of diabetic control is problematic since they are difficult to collect even in hospital settings. In addition, postprandial blood glucose levels measure control at brief points in time and may not relate to the patient's general level of diabetic control.

It is generally accepted that the issue of compliance as it relates to level of control and possible complications is vital to the area of chronic illness in general, and diabetes in particular. However, results are mixed and difficult to interpret. In order to establish whether there is actually a causal link, methods of measuring the various components must be improved. Clearly the major reasons for this gap in the area of IDDM are that

1) The definition of control has varied among investigators, and diabetologists have been unable to reach a consensus on a precise definition so that studies have used varying measures of control (Spevack, Johnson, Harkavy, Silverstein, Shuster, Rosenbloom, and Malone, 1987). There have been recent improvements in this situation with the general acceptance of HbA_1c, although some investigators balk at using this as the sole measure of control since it does not

accurately reflect variability in blood glucose.

2) The measurement of adherence behaviors is equally problematic. Little psychometric data are provided as to the quality of the measures used. Compliance and control are often confused or the same rater judges both. Compliance is often treated as a global construct although there is mounting evidence that it is complex, consisting of several independent components. Studies focus on behaviors that do not relate directly to control. For example, wearing a medic alert bracelet is definitely important in case of accident (Schafer et al., 1982). However, wearing it may not have a direct impact on glycemic control.

3) Correlational studies have been inconsistent in demonstrating a relationship between compliance and control. In any case, data from these studies cannot be used to establish causality.

4) The few intervention studies available suggest that adherence may be improved. However, improved adherence is not always associated with improved control (Epstein and Cluss, 1982). In some intervention studies,

only a single behavior is targeted for intervention or selected for treatment by the parent of the diabetic child. In such cases, the adherence behaviors improved may have no significant impact on diabetic control.

5) It is very difficult to study IDDM youngsters under controlled conditions, where behavior can be reliably measured, without interfering with or disrupting the youngster's normal behavior.

Many investigators have dealt with the first problem by relying predominantly on the best single estimator of control--namely, hemoglobin A_1c--which is an indicator of integrated plasma glucose levels over approximately 3 months. Consequently, to establish a link between adherenc-e/behavior and control as measured by hemoglobin A_1c, a 3-month behavior monitoring system should be available. Unfortunately, youngsters balk at keeping diaries even for short intervals and even when they do keep such records, reliability checks are problematic. To date the most systematic procedure for measuring compliance has been developed by Johnson, Silverstein, Rosenbloom, Carter, and Cunningham (1986). A 24-hour recall interview technique was used to assess daily management behaviors in four diabetes relevant areas (diet, injection, exercise, and glucose testing). Each child and his/her parent were interviewed separately on three different occasions concerning the

child's diabetes management behaviors in the last 24 hours. Interviews were conducted by phone and took approximately 20 minutes. Data from this procedure were used to measure 13 different diabetes management behaviors: injection regularity, injection interval, injection-meal timing, regularity of injection-meal timing, calories consumed, percent calories: fat, percent calories: carbohydrates, concentrated sweets, eating frequency, exercise duration, exercise type, exercise frequency, and glucose testing frequency. Pearson product moment correlations for all 13 adherence measures were conducted to asses parent-child agreement. The results are presented in Table 1. Although all of the correlations were statistically significant ($p<.0001$), a number of measures differed in agreement depending on the age of the child with the youngest children (6-9 years) showing poorest parent/child agreement on measures involving time and the 10- to 12- and 13- to 15-year old groups showing the most consistent parent/child agreement across all measures. The oldest group (16-19 years) had highly variable parent/child correlations. The authors attribute these findings to the reduction of parental supervision during late adolescence when children spend more time with peers outside of the parents' purview. The 13 adherence measures were then subjected to a principal component factor analysis resulting in a five-factor solution accounting for 71.3% of the variance. The five factors were rotated to simple structure using the varimax procedure. Factor I (Exercise) consisted

TABLE 1
Parent-Child Correlations for Total Sample and by Age Group

Adherence Measure	Total Sample r(n) p <	Group 1 (6-9 Years) r(n) p <	Group 2 (10-12 Years) r(n) p <	Group 3 (13-15.6 Years) r(n) p <	Group 4 (16-19 Years) r(n) p <
Injection Regularity	.61(152) (.0001)	.46(27) (.02)	.68(65) (.0001)	.83(42) (.0001)	-.04(18) (.86)
Injection interval	.77(154) (.0001)	.36(29) (.05)	.71(67) (.0001)	.54(40) (.003)	.91(18) (.0001)
Injection-meal timing	.67(163) (.0001)	.53(31) (.002)	.547(68) (.0001)	.60(44) (.001)	.78(20) (.0001)
Regularity of injection-meal timing	.42(148) (.0001)	-.23(26) (.26)	.50(63) (.0001)	.58(41) (.0001)	.46(18) (.05)
Calories consumed	.77(139) (.0001)	.79(30) (.0001)	.80(66) (.0001)	.61(33) (.0001)	.92(10) (.0002)
Percentage calories-fat	.64(167) (.0001)	.50(31) (.005)	.63(70) (.0001)	.76(44) (.0002)	.60(22) (.003)

TABLE 1
(continued)

Adherence Measure	Total Sample r(n) p <	Group 1 (6-9 Years) r(n) p <	Group 2 (10-12 Years) r(n) p <	Group 3 (13-15.6 Years) r(n) p <	Group 4 (16-19 Years) r(n) p <
Percentage calories-carbohydrate	.64(167) (.0001)	.44(31) (.01)	.63(70) (.0001)	.81(44) (.0001)	.62(22) (.002)
Concentrated Sweets	.62(167) (.0001)	.47(31) (.007)	.71(70) (.0001)	.76(44) (.0001)	.12(22) .58
Eating frequency	.45(167) (.0001)	.67(31) (.0001)	.47(70) (.0001)	.54(44) (.0002)	.13(22) (.57)
Exercise duration	.59(167) (.0001)	.03(31) (.87)	.96(70) (.0001)	.79(44) (.0001)	.47(22) (.03)
Exercise type	.54(167) (.0001)	.74(31) (.0001)	.99(70) (.0001)	.66(44) (.0001)	.32(22) (.15)
Exercise frequency	.62(167) (.0001)	.62(31) (.0002)	.72(70) (.0001)	.72(44) (.0001)	.32(22) (.13)
Glucose testing frequency	.78(164) (.0001)	.81(31) (.0001)	.73(68) (.0001)	.77(44) (.0001)	.37(21) (.10)

Table from Johnson, et al., 1986

of the three exercise measures, Factor II (Injection) consisted of all four injection measures, Factor III (Diet Type) was made up of measures of diet type, Factor IV (Eating/Glucose Testing Frequency) included measures of eating frequency and glucose testing frequency, and Factor V (Diet Amount) included measures of total calories consumed and the amount of concentrated sweets ingested. The Johnson et al. (1986) results indicate that adherence to a diabetic regimen consists of five independent constructs and should not be viewed as a global construct.

Diabetes summer camps offer a natural but relatively controlled environment. Here youngsters' behavior and metabolic control could be easily monitored and both would be expected to change. Such an environment would be conducive to investigating relationships of compliance/control. Diabetes summer camps have as their main goal to create an environment in which IDDM youngsters can meet other children with diabetes and learn to live more normally with their disease. The focus of the program is usually to provide a model for healthy living along with didactic components designed to reinforce adherence skills and increase understanding of the disease. It is a generally accepted philosophy that research conducted at summer camps must be nonintrusive and must not interfere with camper activities and enjoyment. The major criticism leveled at camp studies is that they constitute an unnatural environment which itself affects the youngsters' behavior and level of

control. Whether this is a valid criticism and if so, whether the effects are positive or negative, has never been comprehensively evaluated. There is evidence that diabetes camp may improve diabetic control although only one study specifically addressed this issue (Strickland et al., 1984).

The Strickland et al. study examined changes in glycemic control during a 2-week summer camp program by performing pre-camp and post-camp values of fasting plasma glucose, glycosylated hemoglobin, and glycosylated serum protein in a group of 36 children. Their results suggested that there was measurable improvement in diabetic control in some children.

Similarly, only a few studies have addressed behavioral changes associated with camp. For example, Stunkard and Pestka (1962) examined physical activity at a 2-week Girl Scout camp and found that there was significantly more activity during camp compared with at-home behavior. The youngsters studied did not have diabetes.

Most camp studies deal with psychological constructs. Moffatt and Pless (1983) investigated changes in locus of control in juvenile diabetic campers during a 3 week camp experience and found that there were significant changes toward internal locus of control.

Self-concept was scrutinized using the Tennessee Self-Concept Scale with 26 IDDM adolescents (aged 13-17) attending an 8-day summer camp (Hoffman, Guthrie, Speelman, and Childs, 1982). The authors report that self-concept may be

more resistent to change above the age of 14 and that initial level of control was not a significant predictor of self-concept change. The greatest change occurred in the 13- to 14-year old females who improved on self-concept significantly. However, this study did not address the issue of whether self-concept change was associated with change in glycemic control.

In a more recent study, Scharf, Adams, and Leach (1987) compared 45 IDDM adolescents aged 12 to 17 who attended a residential diabetes summer camp, to IDDM youngsters who did not attend camp on psychological functioning immediately following the camp experience and at a 5 month follow- up. They reported that campers' adjustment to diabetes, their self-worth, and their parents' perceptions of their behavioral competencies and general personality adjustment did not change due to the camp experience. Moreover, metabolic control as measured with HbA_1c before camp did not differentially influence the experimental or control subjects in how they reacted to the camp experience or how they adjusted to a chronic illness. No attempt was made to assess whether the camp experience affected glycemic control after camp.

The effects of stress on glycemic control were examined at a 1982 Tennessee camp for diabetic children using 39 adolescents between the ages of 12 and 15 years (Hanson and Pichert, 1986). The children were followed for 3 days while insulin administration, dietary intake, exercise, self-

reported stress, and blood glucose levels (measured via Chemstrip bG Reagent strips four times during the 24 hours preceding each afternoon rest period during which stress questionnaires were administered) were monitored. Results suggested that negative cumulative stress, as perceived by the youngsters, correlated significantly with blood glucose levels. Interestingly, positive cumulative stress was significantly and negatively correlated with girls' blood glucose levels.

Educational experiences at camp were found to contribute to the knowledge and performance of self-care techniques in a study by Lebovitz, Ellis, and Skyler (1978). Harkavy et al. (1983) found that knowledge increased in 12- to 15-year old campers but not in 10- to 11-year olds. Dorchy, Loeb, Mozin, Lemiere, and Ernould (1982) administered a 27 question pre- and post-test to 63 IDDM youngsters and found that regardless of age or duration of diabetes all children ages 9 to 15 years benefit from the teaching of theory and practical issues. The youngest children (9-10 years) showed progress in all areas while the oldest (13-15 years) made greater gains in the areas of nutrition and insulin therapy.

There is, therefore, some evidence that the camp experience may affect psychological factors such as locus of control (Moffat and Pless, 1983) and self-esteem (Hoffman, et al., 1982), knowledge about the disease (particularly in 12- to 15-year old youngsters, Harkavy et al., 1983), self-

care (Lebovitz et al., 1978), and physical activity levels (Stunkard and Pestka, 1962). Moreover, there is some evidence that metabolic control may improve during the camp session (Strickland et al., 1984).

Improvements in adherence behaviors are assumed to occur since camp provides exercise opportunities and the youngsters' regimen is regulated regarding injections and meals. There are, however, no empirical data documenting improved adherence at camp nor attesting to the relationship between such behavior change and improvements in metabolic control. Further, it is unclear whether any behavioral changes induced by the camp setting are maintained once the child returns home.

Glycosylated serum proteins (GSP) differ from glycosylated hemoglobins (GH) in that serum protein levels in the blood change more rapidly than do hemoglobin values with changes in blood glucose concentration (Mehl, Wenzel, Russel, Gardner, and Merimee, 1983). Therefore, since glycosylated serum proteins have been shown to accurately reflect alteration of mean glycemic levels 1 to 2 weeks prior to testing, it becomes feasible to address the issue of whether adherence behaviors at camp are indeed related to metabolic control at camp. This study will, therefore, assess the following:

1) The effect of summer camp on children's diabetes management behavior;

2) The effects of a diabetes summer camp environment on children's diabetes control;

3) The length of time that effects of camp are maintained--i.e., do changes or effects of camp dissipate once the child returns home;

4) The relationship between adherence behavior and level of diabetic control.

This proposed investigation represents a naturalistic study in which the experience of camp is expected to actually change both the children's behavior and their levels of diabetic control thereby providing the opportunity to monitor both. Therefore, the behavior and the levels of control are being naturally manipulated by virtue of the youngsters' attendance at camp, providing an ideal situation to assess the extent to which changes in diabetic control are associated with changes in behavior. Should such changes be demonstrated, and their association be established, it would constitute strong support for a relationship between behavior and health status.

METHOD

Sample Characteristics

Participants were 64 IDDM youngsters who attended the 1985 North Florida Camp for Children and Youth with Diabetes. The 1985 camp session lasted 2 weeks. One parent of each youngster was also asked to participate. Informed consent was obtained from all participants. Youngsters were between the ages of 7-12 (with a mean age of 10.5 years). There were 34 boys and 30 girls. Participating families reported income in 5 categories: 1= $ 0 to $9,999, 2= $10,000 to $19,999, 3= $20,000 to $29,999, 4= $30,000 to $39,999, and 4= $40,000+. Of all participating families 14.5% were in category 1, 27.3% in 2, 23.6% in 3, 18.2% in 4, and 16.4% in 5. All but one (98.4%) of the youngsters had had diabetes for at least 1 year with a range from .9 years to 9.1 years (Table 2). All but one of the youngsters were Caucasian. Only two youngsters dropped out of the study after camp.

Measures

Adherence Measures

Twenty-four hour recall interviews, conducted with children and parents, were recorded on Diabetes Daily Record forms to assess the youngsters' diabetes related

TABLE 2
Sample Characteristics

		Total Sample	Group 1 7-9 Years	Group 2 10-11.4 Years	Group 3 11.5-12.6 Years
Sample Size		64	20	23	21
Sex:	Males	34	13	13	8
	Females	30	7	10	13
Family Income in categories:	1	14.5%	0%	28.6%	11.1%
	2	27.3%	31.3%	28.6%	22.2%
	3	23.6%	25.0%	23.8%	22.2%
	4	18.2%	18.8%	9.5%	27.8%
	5	16.4%	25.0%	9.5%	16.7%
Age:	Mean	10.5	8.5	10.8	12.2
	Range	7.6-12.6	7.6-9.1	10.1-11.1	11.6-12.6
	Stand. Dev.	1.57	.65	.36	.47
Duration:	Mean	3.9	3.6	3.3	4.9
	Range	.9-9.1	1-5.1	.9-4.4	1.1-8.3
	Stand. Dev.	2.67	2.11	2.18	3.37

behaviors before, during and after camp (see Appendix). The interviews were conducted by telephone. When possible, two of these interviews dealt with weekdays and one with weekend activities. Participants were told that the interviewer was concerned with what actually transpired rather than what they believe should have been done. Trained, undergraduate research assistants conducted these interviews. Participants were asked to recall the previous day's activities in a sequential manner beginning with when the child woke up and ending with when he went to bed. All diabetes relevant behaviors were recorded. Interviewers prompted for information that may have been inadvertently omitted, such as, mid-morning snacks, exercise, glucose testing, etc. Youngsters and their parents were interviewed separately.

Using data obtained from the 24 hour recall interviews, 13 different adherence measures were quantified. For each measure, a range of scores is possible with higher scores indicating relative noncompliance and lower scores indicating relative compliance (Johnson et al., 1986):

1) Injection Regularity--this measure assessed the degree to which injections were given at the same time every day. It was calculated by measuring the standard deviation of injection times reported across the interviews.

2) Injection Interval--this measure assessed the youngster's average deviation from an ideal

injection interval of 24 hours between a.m. injections. For youngsters who take p.m. injections, an ideal shot interval was arbitrarily defined as 10 hours between a.m. and p.m. injections on the same day, and 14 hours between the p.m. injection and the a.m. injection on the following day.

3) Injection-Meal Timing--this measure evaluated the timing of injection in relationship to meals. It was calculated by averaging the number of minutes between taking an injection and eating a meal. Sixty minutes were added to this average so that youngsters taking their injection 60 minutes before a meal received an adherence score of zero. Youngsters who, on the average, took their injections 60 minutes to 1 minute before meals received scores from 0 to .99. Youngsters who usually took their injections at the time of their meals or after eating received scores of 1.0 or greater.

4) Regularity of Injection-Meal Timing--this measure appraised the regularity of intervals between injections and eating. This was measured by calculating the standard deviation of the Injection-Meal Timing measure described above.

5) Calories Consumed--for each youngster, an ideal number of total daily calories was identified based on the youngster's age, sex, and ideal weight for height. Ideal weight for height was obtained from tables provided in a standard textbook on childhood obesity (Collipp, 1980). Ideal calorie consumption per kilogram was calculated using standards provided by the U.S. Public Health Service (Anderson et al., 1981). Each child's ideal total number of daily calories was then subtracted from the youngster's reported daily caloric consumption. Reported calorie consumption was obtained from the diet information obtained by interview. All diet information was coded in exchange units from which calorie estimates were derived (Franz, 1983). A high score on the calorie consumed measure indicated that the youngster ate more than his ideal total number of daily calories. A zero score indicated that the child's actual calorie consumption equalled that of his ideal calorie consumption. A negative score indicated that the youngster ate less than the ideal.

6) Percent Calories: Fat--based on the exchange unit information collected from the 24-hour

recall interviews, the percent of total calories consumed which consisted of fat was calculated. Ideal fat consumption was based on the lower limit (25%) recommended by the American Diabetes Association (Nuttal and Brunzall, 1979). Ideal fat consumption (25%) was subtracted from actual fat consumption. Scores above zero indicated that the child consumed more than 25% of his calories in fats. Scores below zero indicated that the child's fat intake was less than 25% of his total calories.

7) Percent Calories: Carbohydrates--this measure was also based on the exchange unit information collected from the 24-hour recall interviews. Ideal carbohydrate consumption was based on the upper limit (60%) recommended by the American Diabetes Association (Nuttal and Brunzall, 1979). In this case actual carbohydrate consumption was subtracted from the ideal (60%) so that scores above zero indicated insufficient carbohydrate ingestion. A score of zero indicated the child's diet consisted of 60% carbohydrates. Scores below zero indicated that more than 60% of the calories consumed consisted of carbohydrates. No measure of

protein consumption was developed since it can be automatically determined by knowing the child's fat and carbohydrate consumption.

8) Concentrated Sweets--forty calories of any concentrated sweet was considered equivalent to one concentrated sweet exchange unit. The average number of these exchange units consumed per day was calculated.

9) Eating Frequency--based on an ideal of six meals/snacks per day, the percent of snacks or meals not eaten across the interviews was calculated and multiplied by 100. A high score indicates that the child ate infrequently. A low score indicated frequent eating occasions. A score of zero indicated the child averaged six meals or snacks per day.

10) Exercise Duration--the average amount of time the child spent exercising during each exercise occasion across the interviews was calculated and a constant (1) was added to avoid subsequent division by zero. The reciprocal of this score was used so that low scores indicated lengthy exercise and high scores indicated little or no exercise.

11) Exercise Type--each exercise or activity was given an energy expenditure rating (Katch and

McArdle, 1977). Higher ratings indicated more strenuous exercise. The youngster's average expenditure rating across the interviews was calculated and a constant (1) was added to avoid subsequent division by zero. The reciprocal of this score served as the measure of Exercise Type; low scores indicated more strenuous exercise while high scores indicated less strenuous exercise.

12) Exercise Frequency--the occurrence or nonoccurrence of exercise on three occasions per day--morning, afternoon, and evening--was noted for each of the interviews. The percent of nonoccurrence of exercise across these occasions was used as an estimate of exercise frequency. A score of zero indicated that the child reported exercise on all occasions. A score of 100 indicated no reported exercise on any occasion.

13) Glucose Testing Frequency--the frequency of glucose testing across the interviews was calculated. Using an ideal testing frequency of four times per day, the number of glucose tests was divided by this ideal (e.g., 12 for 3 days) and multiplied by 100. The total was subtracted from 100 so that high scores indicated few glucose tests and low scores

indicated frequent glucose tests. A score of zero indicated the youngster tested 4 times per day. A score of 100 indicated no reported glucose tests over the interviews.

Glycemic Control Measures

Glycosylated hemoglobin A_1c levels were obtained at the beginning of camp and at 3 months following camp. The assays were performed at the Shands Teaching Hospital Laboratory using a column chromatography method performed with Glyco-Gel kits. The expected normal range for Glycosylated Hemoglobin A_1c (HbA_1c) using this procedure was 3.5-6.2% and represents an overall estimate of glycemic control for a period of approximately 3 months prior to testing.

Glycosylated serum proteins (GSP) were obtained at the beginning and end of the 2-week camp session to evaluate any changes in glycemic control associated with the camp experience. The assays were performed at the Shands Teaching Hospital Laboratory using the Pierce GlycoTest in vitro diagnostic kits which contain GLYCO-GEL Analytical Columns. This is an affinity chromatography based method used after serum is first dialyzed against normal saline to prevent spurious elevations of GSP levels due to free glucose (Kennedy, 1981). GSP represents the average glycemic control for a period of 10 to 14 days before testing. Normal ranges were not available. However, in this analysis the control value for a nondiabetic subject ranged from .47 to 1.1% with a mean of .79%.

Procedure

In the 2 weeks prior to attending diabetes summer camp, each child and one of his parents were interviewed by phone on three separate occasions using the 24-hour recall technique described earlier. The interviews were recorded on the Diabetes Daily Record (Appendix).

On the first or second day of camp, fasting blood was obtained from each participant. Serum obtained from venous samples was stored at -20 degrees centigrade to be assayed for GSP at a later time. Heparinized blood samples were submitted for HbA_1c assays. During their 2-week camp experience, each child and his counselor were interviewed on three separate occasions (on 2 weekdays and 1 weekend day) by trained interviewers who recorded diabetes management behaviors for the previous day on the Diabetes Daily Record. However, counselor interviews were discontinued as it became clear that they had difficulty differentially remembering the individual children's activities and food consumption. During the last 2 days of camp, fasting blood was again obtained for GSP analysis. Those children whose blood was drawn on the first day of camp were drawn on the second to last day of camp. Similarly, if their blood was first drawn on the second day of camp, the second sample was obtained on the last full day of camp.

Within the 2 weeks following camp, study participants and their parents again participated in three telephone interviews using the 24-hour recall technique. This

procedure was repeated at 6 and 12 weeks post-camp. At 12 weeks post-camp, a second HbA_1c sample was obtained.

RESULTS

Reliability of Child Report

One possible measure of child report reliability is parent-child agreement. Perfect agreement was not expected since parents are not always able to observe everything the child does. However, since counselors were unable to provide useful data concerning the campers activities, the youngsters were the only consistent reporters available and the issue of their reliability in reporting their behaviors was critical.

Estimates of agreement between parent and child were calculated to indicate the reliability of the information obtained from the youngsters at camp, using Pearson product moment correlations. These analyses replicated the Johnson et al. study (1986) and used their 13 adherence measures. Agreement was assessed for the total sample and for three age groups (7-9, 10-11.4, and 11.5-12.6) at four points in time: pre-camp and post-camp on 3 separate occasions (immediately after camp, 6 weeks after camp, and 3 months after camp). These data are presented in Tables 3, 4, 5, and 6.

For the pre-camp period, parent/child correlations for the total sample were all significant at $p < .02$, except for regularity of injection-meal timing. One or both of the two

TABLE 3
Parent-Child Correlations for Total Sample and by Age Group
Pre-Camp

Adherence Measure	Total Sample r(n) p <	Group 1 (7-9 Years) r(n) p <	Group 2 (10-11.4 Years) r(n) p <	Group 3 (11.5-12.6 Years) r(n) p <
Injection regularity	.65(60) (.0001)	.80(18) (.0001)	.28(21) (.2156)	.82(21) (.0001)
Injection interval	.75(59) (.0001)	.51(19) (.0262)	.92(19) (.0001)	.64(21) (.0018)
Injection-meal timing	.54(62) (.0001)	-.03(19) (.8885)	.57(22) (.0052)	.75(21) (.0001)
Regularity of injection-meal timing	.09(59) (.5010)	-.08(18) (.7382)	-.08(20) (.7450)	.42(21) (.0526)
Calories consumed	.73(62) (.0001)	.81(20) (.0001)	.62(22) (.0023)	.84(20) (.0001)
Percentage calories-fat	.78(63) (.0001)	.86(20) (.0001)	.64(22) (.0013)	.73(21) (.0002)

TABLE 3
(continued)

Adherence Measure	Total Sample r(n) p <	Group 1 (7-9 Years) r(n) p <	Group 2 (10-11.4 Years) r(n) p <	Group 3 (11.5-12.6 Years) r(n) p <
Percentage calories-carbohydrate	.72(63) (.0001)	.80(20) (.0001)	.65(22) (.0011)	.69(21) (.0005)
Concentrated sweets	.63(63) (.0001)	.35(20) (.1292)	.71(22) (.0002)	.63(21) (.0020)
Eating frequency	.72(63) (.0001)	.83(20) (.0001)	.64(22) (.0013)	.73(21) (.0020)
Exercise duration	.29(63) (.0211)	.68(20) (.0010)	.07(22) (.7603)	.96(21) (.0001)
Exercise type	.64(63) (.0001)	.76(20) (.0001)	.56(22) (.0071)	.62(21) (.0029)
Exercise frequency	.68(63) (.0001)	.81(20) (.0001)	.50(22) (.0190)	.68(21) (.0007)
Glucose testing frequency	.90(63) (.0001)	.89(20) (.0001)	.97(22) (.0001)	.68(21) (.0006)

TABLE 4
Parent-Child Correlations for Total Sample and by Age Group
Immediately Post-Camp

Adherence Measure	Total Sample r(n) p <	Group 1 (7-9 Years) r(n) p <	Group 2 (10-11.4 Years) r(n) p <	Group 3 (11.5-12.6 Years) r(n) p <
Injection regularity	.54(55) (.0001)	.54(15) (.0381)	.52(20) (.0198)	.65(20) (.0021)
Injection interval	.73(56) (.0001)	.67(16) (.0045)	.66(20) (.0016)	.83(20) (.0001)
Injection-meal timing	.68(57) (.0001)	.31(18) (.2152)	.91(19) (.0001)	.56(20) (.0098)
Regularity of injection-meal timing	.44(54) (.0008)	-.40(15) (.1432)	.42(19) (.0726)	.72(19) (.0003)
Calories consumed	.62(59) (.0001)	.36(18) (.1471)	.62(22) (.0022)	.70(19) (.0009)
Percentage calories-fat	.74(60) (.0001)	.68(18) (.0020)	.87(22) (.0001)	.62(20) (.0035)

TABLE 4
(continued)

Adherence Measure	Total Sample r(n) p <	Group 1 (7-9 Years) r(n) p <	Group 2 (10-11.4 Years) r(n) p <	Group 3 (11.5-12.6 Years) r(n) p <
Percentage calories-carbohydrate	.75(60) (.0001)	.63(18) (.0048)	.85(22) (.0001)	.70(20) (.0006)
Concentrated sweets	.59(60) (.0001)	.58(18) (.0108)	.83(22) (.0001)	.34(20) (.1415)
Eating frequency	.67(60) (.0001)	.77(18) (.0002)	.59(22) (.0037)	.63(20) (.0026)
Exercise duration	.21(60) (.1106)	.53(18) (.0234)	.21(22) (.3568)	.13(20) (.5965)
Exercise type	.64(60) (.0001)	.66(18) (.0028)	.50(22) (.0171)	.85(20) (.0001)
Exercise frequency	.68(60) (.0001)	.67(18) (.0024)	.53(22) (.0117)	.92(20) (.0001)
Glucose testing frequency	.78(60) (.0001)	.55(18) (.0171)	.92(22) (.0001)	.68(20) (.0009)

TABLE 5
Parent-Child Correlations for Total Sample and by Age Group
Six Weeks Post-Camp

Adherence Measure	Total Sample r(n) p <	Group 1 (7-9 Years) r(n) p <	Group 2 (10-11.4 Years) r(n) p <	Group 3 (11.5-12.6 Years) r(n) p <
Injection regularity	.64(53) (.0001)	.57(14) (.0320)	.66(20) (.0017)	.67(19) (.0019)
Injection interval	.66(53) (.0001)	.45(15) (.0942)	.79(20) (.0001)	.81(18) (.0001)
Injection-meal timing	.76(56) (.0001)	.11(16) (.6915)	.76(21) (.0001)	.95(19) (.0001)
Regularity of injection-meal timing	.26(52) (.0615)	.11(14) (.7032)	.34(19) (.1501)	.46(19) (.0461)
Calories consumed	.69(56) (.0001)	.49(17) (.0456)	.65(21) (.0014)	.85(18) (.0001)
Percentage calories-fat	.86(57) (.0001)	.96(17) (.0001)	.76(21) (.0001)	.84(19) (.0001)

TABLE 5
(continued)

Adherence Measure	Total Sample r(n) p <	Group 1 (7-9 Years) r(n) p <	Group 2 (10-11.4 Years) r(n) p <	Group 3 (11.5-12.6 Years) r(n) p <
Percentage calories-carbohydrate	.83(57) (.0001)	.93(17) (.0001)	.70(21) (.0004)	.86(19) (.0001)
Concentrated sweets	.68(57) (.0001)	.92(17) (.0001)	.70(21) (.0004)	.55(19) (.0141)
Eating frequency	.74(57) (.0001)	.62(17) (.0080)	.74(21) (.0001)	.85(19) (.0001)
Exercise duration	.30(57) (.0235)	.20(17) (.4428)	.61(21) (.0035)	.23(19) (.3383)
Exercise type	.56(57) (.0001)	.49(17) (.0442)	.63(21) (.0021)	.76(19) (.0001)
Exercise frequency	.58(57) (.0001)	.40(17) (.1150)	.75(21) (.0001)	.70(19) (.0009)
Glucose testing frequency	.91(57) (.0001)	.85(17) (.0001)	.96(21) (.0001)	.93(19) (.0001)

TABLE 6
Parent-Child Correlations for Total Sample and by Age Group
Three Months Post-Camp

Adherence Measure	Total Sample r(n) p <	Group 1 (7-9 Years) r(n) p <	Group 2 (10-11.4 Years) r(n) p <	Group 3 (11.5-12.6 Years) r(n) p <
Injection regularity	.81(55) (.0001)	.81(17) (.0001)	.88(18) (.0001)	.74(20) (.0002)
Injection interval	.89(52) (.0001)	.76(18) (.0002)	.95(15) (.0001)	.93(19) (.0001)
Injection-meal timing	.77(60) (.0001)	.47(19) (.0422)	.78(21) (.0001)	.86(20) (.0001)
Regularity of injection-meal timing	.25(54) (.0665)	.22(17) (.4001)	-.11(17) (.6710)	.38(20) (.1011)
Calories consumed	.69(60) (.0001)	.11(20) (.6344)	.64(21) (.0016)	.75(19) (.0002)
Percentage calories-fat	.66(61) (.0001)	.75(20) (.0001)	.62(21) (.0026)	.65(20) (.0019)

TABLE 6
(continued)

Adherence Measure	Total Sample r(n) p <	Group 1 (7-9 Years) r(n) p <	Group 2 (10-11.4 Years) r(n) p <	Group 3 (11.5-12.6 Years) r(n) p <
Percentage calories-carbohydrate	.65(61) (.0001)	.68(20) (.0009)	.69(21) (.0006)	.65(20) (.0017)
Concentrated sweets	.43(61) (.0005)	.37(20) (.1078)	.25(21) (.2666)	.69(20) (.0008)
Eating frequency	.80(61) (.0001)	.51(20) (.0228)	.85(21) (.0001)	.90(20) (.0001)
Exercise duration	.66(61) (.0001)	.68(20) (.0011)	.67(21) (.0009)	.77(20) (.0001)
Exercise type	.68(61) (.0001)	.51(20) (.0227)	.74(21) (.0001)	.77(20) (.0001)
Exercise frequency	.71(61) (.0001)	.71(20) (.0005)	.69(21) (.0006)	.76(20) (.0001)
Glucose testing frequency	.91(61) (.0001)	.89(20) (.0001)	.96(21) (.0001)	.85(20) (.0001)

younger groups exhibited poor correlations on measures involving time (injection regularity, injection-meal timing, regularity of injection-meal timing, and exercise duration). However, the oldest children were significantly correlated with their parents ($p < .05$) on all measures (Table 3).

Immediately after camp (Table 4), the parent/child correlations for the total sample were all significant with the exception of exercise duration. Injection-meal timing and regularity of injection-meal timing were still problematic for the 7- to 9-year olds. The 10- to 11.4-year olds exhibited poor correlations on regularity of injection-meal timing and exercise duration, while the oldest youngsters were not significantly correlated with their parents on measures of concentrated sweets and exercise duration (Table 4).

The 6 weeks and 3 months after camp interviews demonstrate a similar pattern. These results are presented in Tables 5 and 6 respectively. Percentage calories: fat, percentage calories: carbohydrates, eating frequency, exercise type, and glucose testing demonstrated significant correlations for all children. Regularity of injection-meal timing and exercise duration demonstrated the weakest (nonsignificant) correlations in each of the study periods except for the last one in which parent/child agreement for exercise duration improved ($r=.66$). However, parent/child agreement for regularity of injection-meal timing remained weak ($r=.25$).

In addition to the parent/child correlations calculated for each time period, the interviews were also collapsed across time periods to determine the overall correlations by age group (Table 7). Parents and children's reports for the total sample were significantly correlated for all 13 measures, ranging from r=.36 (p<.004) on regularity of injection-meal timing to r=.92 (p<.0001) for glucose testing frequency. Comparisons between independent correlations using Fisher's z' transformation were conducted to assess differences in the degree of parent/child agreement across the three age groups ($p < .05$, Cohen and Cohen, 1983, pages 53-56). These tests revealed that on 5 of the 13 adherence measures (injection interval, injection-meal timing, calories consumed, exercise duration, and glucose testing frequency) there were significant differences in the parent/child correlations among the three age groups (see Table 7). The 10- to 11.4-year old demonstrated the highest agreement (r=.92) with their parents on the injection interval measure while the 7- to 9-year olds' reports did not correspond as well (r=.51). On the injection-meal timing measure, the oldest youngsters' reports corresponded best with their parents (r= .75), while the 7- to 9-year olds demonstrated the worst parent/child agreement (r= -.03). Similarly, on the calories consumed measure, the oldest group exhibited the highest parent/child correlation (r=.89) and the youngest group displayed the weakest (r=.53). The 11.5- to 12.6-year olds again demonstrated the

TABLE 7
Parent-Child Correlations for Total Sample and by Age Group
Collapsed Across Time

Adherence Measure	Total Sample r(n) p <	Group 1 (7-9 Years) r(n) p <	Group 2 (10-11.4 Years) r(n) p <	Group 3 (11.5-12.6 Years) r(n) p <
Injection regularity	.81(63) (.0001)	.75(20) (.0001)	.88(22) (.0001)	.77(21) (.0001)
Injection * interval	.75(59) (.0001)	.51(19) (.0262)	.92(19) (.0001)	.64(21) (.0018)
Injection- * meal timing	.69(63) (.0001)	-.03(19) (.8885)	.57(22) (.0052)	.75(21) (.0001)
Regularity of injection-meal timing	.36(63) (.0049)	-.08(18) (.7141)	-.08(20) (.7382)	.43(21) (.0526)
Calories * consumed	.81(62) (.0001)	.53(20) (.0163)	.81(22) (.0001)	.89(20) (.0001)
Percentage calories-fat	.91(63) (.0001)	.96(20) (.0001)	.88(22) (.0001)	.89(21) (.0001)

TABLE 7
(continued)

Adherence Measure	Total Sample r(n) p <	Group 1 (7-9 Years) r(n) p <	Group 2 (10-11.4 Years) r(n) p <	Group 3 (11.5-12.6 Years) r(n) p <
Percentage calories-carbohydrate	.89(63) (.0001)	.96(20) (.0001)	.88(22) (.0001)	.84(21) (.0001)
Concentrated sweets	.69(63) (.0001)	.73(20) (.0003)	.80(22) (.0001)	.58(21) (.0054)
Eating frequency	.83(63) (.0001)	.80(20) (.0001)	.77(22) (.0001)	.90(21) (.0001)
Exercise * duration	.63(63) (.0001)	.68(20) (.0010)	.43(22) (.0457)	.86(21) (.0001)
Exercise type	.70(63) (.0001)	.75(20) (.0001)	.60(22) (.0033)	.73(21) (.0002)
Exercise frequency	.76(63) (.0001)	.81(20) (.0001)	.63(22) (.0016)	.86(21) (.0001)
Glucose * testing frequency	.92(63) (.0001)	.86(20) (.0001)	.98(22) (.0001)	.84(21) (.0001)

* indicates significant differences by age group.

highest parent/child agreement (r=.86) on the exercise duration measure, while the 10- to 11.4-year olds exhibited the weakest correlation (r=.43). On the glucose testing frequency measure, all groups' reports correlated highly with their parents, however there was a significant difference between the 10- to 11.4-year olds' (r=.98) and the 11.5- to 12.6-year olds' (r=.84) parent/child correlations.

The correlations between parent and child report were then collapsed across the age groups so that the parent/child correlations for the total sample could be examined across the four time periods of the study. A test of compound symmetry was used to test for the equality of these dependent correlations (Steiger, 1980). Results of these analyses (Table 8) indicated that agreement between parent and child did not differ significantly across time for 8 of the 13 adherence measures: calories consumed; percent calories: fat; percent calories: carbohydrates; eating frequency; exercise duration; exercise type; exercise frequency; and testing frequency. On measures of injection regularity, injection interval, injection-meal timing, regularity of injection-meal timing, and concentrated sweets there were significant differences in the parent/child correlations across two or more time periods. These differences exhibited no consistent pattern. Injection regularity, for example, exhibited the best parent/child agreement at Time 5 (r=.81) and the worst at Time 3 (r=.54), while concentrated sweets exhibited the highest parent/child

TABLE 8
Parent-Child Correlations for Total Sample
Over Four Time Periods: Pre and Post-Camp

Adherence Measure	Time 1 Pre-Camp r(n) p <	Time 3 Post-Camp r(n) p <	Time 4 6 wks Post-Camp r(n) p <	Time 5 3 Mos Post-Camp r(n) p <
Injection * regularity	.65(60) (.0001)	.54(55) (.0001)	.64(53) (.0001)	.81(55) (.0001)
Injection * interval	.75(59) (.0001)	.73(56) (.0001)	.66(53) (.0001)	.89(52) (.0001)
Injection- * meal timing	.54(62) (.0001)	.68(57) (.0001)	.76(56) (.0001)	.77(60) (.0001)
Regularity of * injection- meal timing	.09(59) (.5010)	.44(54) (.0008)	.26(52) (.0615)	.25(54) (.0665)
Calories consumed	.73(62) (.0001)	.62(59) (.0001)	.69(56) (.0001)	.69(60) (.0001)
Percentage calories-fat	.78(63) (.0001)	.74(60) (.0001)	.86(57) (.0001)	.66(61) (.0001)

TABLE 8
(continued)

Adherence Measure	Time 1 Pre-Camp r(n) p <	Time 3 Post-Camp r(n) p <	Time 4 6 wks Post-Camp r(n) p <	Time 5 3 Mos Post-Camp r(n) p <
Percentage calories-carbohydrate	.72(63) (.0001)	.75(60) (.0001)	.83(57) (.0001)	.65(61) (.0001)
Concentrated sweets *	.63(63) (.0001)	.59(60) (.0001)	.68(57) (.0001)	.43(61) (.0005)
Eating frequency	.72(63) (.0001)	.67(60) (.0001)	.74(57) (.0001)	.80(61) (.0001)
Exercise duration	.29(63) (.0211)	.21(60) (.1106)	.30(57) (.0235)	.66(61) (.0001)
Exercise type	.64(63) (.0001)	.64(60) (.0001)	.56(57) (.0001)	.68(61) (.0001)
Exercise frequency	.68(63) (.0001)	.68(60) (.0001)	.58(57) (.0001)	.71(61) (.0001)
Glucose testing frequency	.90(63) (.0001)	.78(60) (.0001)	.91(57) (.0001)	.91(61) (.0001)

* indicates significant differences between correlations across time periods.

agreement at Time 4 (r=.68) and the poorest concordance at Time 5 (r=.43). Only the injection-meal timing measure exhibited any evidence of a linear trend toward improvement in parent/child agreement across time (see Table 8). However, by the end of the study (Time 5) parents and children were significantly correlated on 12 of the 13 adherence measures ($p < .0005$). Only parent/child agreement for the regularity of injection-meal timing remained weak.

Differences between parent and child report were further analyzed with repeated measures ANOVA on each of the 13 adherence measures collapsed across all parent/child interviews using two between subject factors: Age group (7- to 9-year olds, 10- to 11.4-year olds, and 11.5- to 12.6-year olds) and Sex, and one within subject factor: Respondent (parent, child). Results indicated that there were few differences between parent and child report. Simple main effects for Respondent emerged on three measures. On the injection-meal timing measure, parents reported an average of 14 minutes while children reported an average of 19 minutes between injection and meal, $F(1,56)=5.98$, $p < .02$. On the eating frequency measure parents reported that children ate an average of 5.25 meals per day while children reported eating an average of 5 times per day, $F(1,56)= 25.29$, $p < .0001$. On calories consumed parents reported that their children ate approximately 92 calories more than the recommended amount per day while children reported ingesting

approximately 13 calories less than the recommended amount per day, $F(1,55)=6.83$, $p < .01$.

On measures of exercise type and exercise frequency a Respondent x Sex interaction emerged $F(1,56)=9.37$ $p < .003$ and $F(1,56)=7.28$, $p < .009$ respectively. To determine the source of the Respondent x Sex interactions, the data were divided by sex and repeated measures ANOVA were conducted on each of the two exercise measures using one within subject factor (Respondent). For both exercise type and exercise frequency, boys' reports did not significantly differ from their parents' reports. In contrast, girls reported participating in more strenuous and more frequent episodes of exercise than did their parents, $F(1,29)=11.99$ $p < .002$, and $F(1,29)=5.90$ $p < .02$ respectively. These interactions were further examined using T tests to explore possible differences between parents reports of boys' versus girls' exercise type and exercise frequency; parents reported significantly more strenuous and more frequent episodes of exercise for boys compared to girls, $t(62)=-3.35$, $p < .001$. In contrast, the children themselves did not report the same male/female differences found in the parent data.

In summary, the children's reports correlated with their parents reports in the expected direction, both across time and across age groups. In addition, even when differences between parent and child report did exist, they were relatively small and of questionable clinical significance. Since the youngsters' self-report data were

generally reliable, replicating reliability data reported in a previous study (Johnson et al., 1986), and since the counselor interview data were unusable, it was decided to use only the children's report in the succeeding analyses.

Effect of Diabetes Camp on Adherence

To test for possible changes in children's management behaviors during camp, a repeated measures ANOVA was conducted on each of the 13 adherence measures using two between subject factors--Age Group (7-9 years, 10-11 years, 11.5-12.6 years) and Sex (M,F) and one within subjects factor--Time (Time 1: before camp, Time 2: during camp, Time 3: immediately after camp, Time 4: 6 weeks after camp, and Time 5: 3 months after camp). Significant Time main effects or interactions with Time emerged for 9 of the 13 adherence measures (i.e., injection regularity, injection interval, injection-meal timing, calories consumed, eating frequency, exercise duration, exercise type, exercise frequency, and glucose testing frequency). Duncan's Multiple Range Tests performed on these measures revealed that in all cases adherence behaviors at camp (Time 2) differed significantly from one or more of the pre- or post-camp periods (Time 1, Time 3, Time 4, and Time 5). These results are presented in Table 9.

Simple main effects for Time emerged for behaviors associated with injection regularity $F(4,164)=6.04$, $p < .0001$, injection-meal timing $F(4,168)=2.83$, $p < .03$, eating

TABLE 9
Duncan's Multiple Range Tests ($p < .05$) on the Adherence Measures Demonstrating Within Subject Effects

	Time Periods Compared									
	Pre-camp vs Post-camp			Camp vs Pre- and Post-camp				Post-camp		
Adherence Measure	1_3	1_4	1_5	2_1	2_3	2_4	2_5	3_4	3_5	4_5
Injection regularity			#	*	*	*	*		#	#
Injection interval 7-9yrs										
10-11.4yrs										
11.5-12.6yrs				*	*	*	*			
Injection-meal timing				*	*	*	*			
Regularity of injection-meal timing										
Calories consumed 7-9yrs			#	*	*	*			#	#
10-11.4yrs				*	*	*				
11.5-12.6yrs				*	*	*	*			
Percentage calories-fat										

TABLE 9
(continued)

Adherence Measure	Time Periods Compared: Pre-camp vs Post-camp 1_3	1_4	1_5	Camp vs Pre- and Post-camp 2_1	2_3	2_4	2_5	Post-camp 3_4	3_5	4_5
Percentage calories-carbohydrate										
Concentrated sweets										
Eating frequency				*	*	*	*			
Exercise duration	#	#			*	*	*			
Exercise type	#			*	*	*	*		*	
Exercise frequency 7-9yrs	#			*	*	*	*		*	
10-11.4yrs				*	*	*	*			
11.5-12.6yrs	#	#	#	*	*	*	*			
Glucose testing frequency		#	#		*	*	*		#	

* indicates significant improvement.
# indicates significant deterioration.

frequency $F(4,200)=26.15$, $p < .0001$, exercise duration $F(4,200)=5.97$, $p < .0001$, exercise type $F(4,200)=101.08$, $p < .0001$, and testing frequency, $F(4,200)=8.11$ $p < .0001$. In every instance children exhibited more compliant behavior during camp (Table 10).

Repeated measures ANOVA revealed Time main effects as well as Time x Age group interaction effects on 3 additional adherence measures (Table 11): injection interval (Time effect, $F(4,140)=2.45$, $p < .05$; Time x Age group interaction, $F(8,140) = 2.21$, $p < .03$), calories consumed (Time effect, $F(4,196)=7.96$, $p < .0001$; Time x Age group interaction, $F(8,196)=2.39$, $p < .02$), and exercise frequency (Time effect, $F(4,200)=179$, $p < .0001$; Time x Age group interaction, $F(8,200)=2.27$, $p < .02$). However, subsequent analyses indicated that injection interval was the only measure to evidence differential effects at camp for different age groups. That is, the oldest children (11.5-12.6 years) reported significantly improved compliance during camp, while the 7- to 9-year olds and the 10- to 11.4-year olds reported no change on these measures between home and camp. Time x Age group interactions for the calories consumed and exercise frequency measures were due to differences between the age groups at one of the five time periods rather than to a differential effect of camp on the age groups. In fact, all age groups exhibited a significant increase on calories consumed during camp and all youngsters reported a

TABLE 10
Means and Standard Deviations for Adherence
Measures Demonstrating Simple Main Effects for Time

Adherence Measure	Time Period Time 1 Means (SD) (Interp)	Time 2 Means (SD) (Interp)	Time 3 Means (SD) (Interp)	Time 4 Means (SD) (Interp)	Time 5 Means (SD) (Interp)
Injection regularity (minutes)	.47(.38) (28.02)	.27(.27) (15.92)	.50(.35) (30.06)	.46(.31) (27.60)	.68(.55) (40.59)
Injection-meal timing (minutes)	.70(.50) (42.14)	.49(.44) (29.65)	.68(.37) (40.81)	.66(.47) (39.52)	.71(.46) (42.74)
Eating frequency (per day)	15.35(12.62) (5.02)	2.58(3.54) (5.86)	15.31(13.55) (5.07)	17.33(13.93) (4.97)	16.26(14.67) (5.02)
Exercise duration (minutes per occasion)	.09(.14) (20.03)	.03(.01) (42.41)	.16(.23) (14.44)	.17(.24) (15.35)	.12(.18) (14.07)
Exercise type (kilocalories/min)	.97(.01) (.03)	.94(.01) (.06)	.98(.01) (.02)	.97(..02) (.03)	.97(.01) (.03)
Glucose testing frequency (per day)	51.23(24.41) (1.88)	45.80(12.78) (2.17)	54.09(24.50) (1.79)	59.18(26.09) (1.58)	60.80(25.47) (1.53)

TABLE 11
Means and Standard Deviations for Adherence
Measures with Age x Time Interaction at the 5 Time Periods

		Time Period				
		Time 1 Means(SD) (Interp)	Time 2 Means(SD) (Interp)	Time 3 Means(SD) (Interp)	Time 4 Means(SD) (Interp)	Time 5 Means(SD) (Interp)
Adherence Measure						
Injection interval (minutes)	7-9yrs	.43(.41) (25.6)	.46(.54) (27.6)	.63(.65) (37.8)	.98(.66) (58.8)	.45(.34) (26.7)
	10-11.4yrs	.91(.87) (54.8)	1.05(1.9) (63.3)	.94(.73) (56.4)	.79(.77) (47.4)	1.31(1.2) (78.5)
	11.5-12.6yrs	.79(.50) (47.1)	.24(.23) (14.5)	1.28(1.0) (76.54)	.84(.42) (50.3)	1.06(.94) (63.5)
Calories consumed	7-9yrs	-7.4(489)	164.9(962)	-4.1(619)	18.1(721)	277.1(480)
	10-11.4yrs	100.0(843)	598.9(794)	228.5(610)	111.5(693)	297.4(726)
	11.5-12.6yrs	-307.8(612)	382.9(874)	-327.9(533)	-325.3(649)	-396.9(550)
Exercise frequency	7-9yrs	72.9(14.8) (1.8)	30.8(11.7) (4.5)	80.9(12.0) (1.3)	74.8(12.0) (1.6)	67.0(13.4) (2.0)
	10-11.4yrs	73.7(11.1) (1.6)	23.4(9.7) (4.2)	74.2(19.5) (1.6)	71.1(16.3) (1.8)	74.6(13.8) (.07)
	11.5-12.6yrs	69.3(14.3) (.10)	28.4(16.7) (4.3)	80.4(12.5) (.04)	81.2(11.1) (04)	78.4(11.2) (1.3)

significant increase in exercise frequency associated with the camp experience (see Table 9 and 11).

Five Measures exhibited no significant change related to the camp experience: regularity of injection-meal timing, percentage calories: fat, percentage calories: carbohydrates, and concentrated sweets (Table 12).

On the regularity of injection-meal timing measure, there was also an Age group x Sex interaction, $F(2,38)=3.41$, $p < .04$). Subsequent LSMEANS procedure revealed that the 10- to 11.4-year old girls were significantly less adherent than the 11.5- to 12.6-year old girls or the 10- to 11.4-year old boys. No other main or interaction effects for sex emerged for any other adherence measure.

Although it is clear that significant changes occurred during camp for 9 of the 13 adherence behaviors, examination of Table 9 demonstrates that these changes were not maintained. That is, Time 2 (camp) exhibited consistent significant differences from Times 1, 3, 4, and 5. In contrast there were fewer significant differences between Time 1, 3, 4, and 5. When differences between these times did occur, they were most often in the direction of poorer adherence (see Table 9 and interpretations in Tables 10, 11, and 12).

Effect of Diabetes Camp on Glycemic Control

This project used two measures to assess glycemic control. Glycosylated hemoglobin (HbA_1c) which provides an

TABLE 12
Means and Standard Deviations for Adherence
Measures that Remained Stable Over the 5 Time Periods

Adherence Measure	Time Period Time 1 Means(SD) (Interp)	Time 2 Means(SD) (Interp)	Time 3 Means(SD) (Interp)	Time 4 Means(SD) (Interp)	Time 5 Means(SD) (Interp)
Regularity of injection- (minutes) meal timing	18.68(19.3)	18.10(13.5)	19.49(18.2)	12.02(10.4)	18.20(19.22)
Percentage calories-fat	23.67(6.9) (48.7)	22.04(5.7) (47.0)	24.53(7.2) (49.5)	23.99(9.0) (48.9)	22.73(6.5) (47.7)
Percentage calories-carbohydrate	24.33(7.2) (35.7)	23.35(6.0) (36.7)	25.44(7.5) (34.6)	24.76(8.8) (35.2)	23.35(6.7) (36.7)
Concentrated sweets (per day)	1.52(1.9)	1.24(1.1)	1.33(1.8)	1.38(1.7)	1.56(1.7)

average estimation of glycemic control for a period of 2 to 4 months, and glycosylated serum protein (GSP) which provides a measure of glycemic control over a 10 to 14 day period. In order to support the reliability of the laboratory assays, Pearson product moment correlations were performed (Table 13). It was expected that the highest GSP/HbA_1c correlation would occur between the pre-camp GSP measure and the pre-camp HbA_1c measure since they were drawn at the same time and reflect some overlap in time periods. This was found to be the case ($r=.71$, $p < .0001$, Table 13). Further, it was expected that the pre-camp GSP measure would correlate less well with the 3 month followup HbA_1c since these measures reflect entirely different time periods. In fact, the correlation between pre-camp GSP and followup HbA_1c was markedly lower ($r=.52$, $p < .0001$). The lowest GSP/Hba_1c correlations were expected between post-camp GSP and both pre-camp HbA_1c and followup HbA_1c, taken at 3 months after camp, since the GSP and HbA_1c measures reflect completely different time periods and completely different settings (camp versus home). In fact, these correlations ($r=.43$; $r=.39$) represent the lowest correlations in the matrix depicted in Table 13. Overall, the pattern of results depicted in Table 13 supports the reliability of our glycemic control measures.

To assess possible changes in glycemic control due to the camp experience,a repeated measures ANOVA was performed on the GSP pre- and post-camp measures using 2 between

TABLE 13
Correlations Between Glycosylated Hemoglobins
and Serum Proteins

	HbA_1c		GSP	
	pre-camp r(n) p <	3 months post-camp r(n) p <	pre-camp r(n) p <	post-camp r(n) p <
HbA_1c :				
pre-camp	1.00(63) (.0000)			
3 months post-camp	.62(61) (.0001)	1.00(62) (.0000)		
GSP				
pre-camp	.71(53) (.0001)	.52(52) (.0001)	1.00(54) (.0000)	
post-camp	.43(60) (.0007)	.39(59) (.0020)	.78(54) (.0001)	1.00(61) (.0000)

subjects factors (Age group and Sex), and 1 within subjects factor (Time: pre- and post-camp). A significant main effect for Time, $F(1,50)=11.00$, $p < .0017$, and a significant main effect for Age group, $F(2,50)=3.31$, $p < .0447$ emerged. Subsequent LSMEANS procedures revealed that the overall mean GSP values increased from 5.63% to 6.44% and that the 7- to 9-year olds (5.40%) and the 11- to 11.4-year old youngsters (5.23%) had significantly lower mean GSP values than the 11.5- to 12.6-year old youngsters (6.82%).

It was then hypothesized that children arriving at camp at different levels of glycemic control may have been differentially affected by the camp experience. Therefore, the youngsters were assigned to good (GSP less than 4.5%), moderate (GSP between 4.5 and 7.0%), and poor control (GSP greater than 7.0%) categories based on groupings apparent from a univariate procedure on the pre-camp GSP values. Repeated measures ANOVA on the GSP values pre- and post-camp was conducted using one between subjects factor (GSP control group) and one within subjects factor (Time: pre- and post-camp). Results indicated a significant main effect for Time, $F(1,51)=12.45$, $p < .0009$, and a significant main effect for GSP control group, $F(2,51)=55.91$, $p < .0001$. However, the Time x GSP control group interaction was not significant, indicating that the various control groups did not react differentially to the camp experience.

To assess changes in HbA_1c, a repeated measures analysis of variance (ANOVA) was conducted on the HbA_1c pre-

camp and at followup using 2 between subjects factors (Age group and Sex), and 1 within subjects factor (Time). There were no significant main effects for Time and no significant interactions, indicating that the camp experience had no perceivable lasting effect. However, it was hypothesized that the youngsters may have demonstrated differences depending on their glycemic level of control before camp. Therefore, based on a univariate procedure performed on HbA_1c drawn at the beginning of camp, the children were divided into good (HbA_1c less than 8.4%), moderate (HbA_1c between 8.4 and 10.4%), and poor (HbA_1c greater than 10.4%) HbA_1c control groups. A repeated measures ANOVA procedure was conducted on the HbA_1c (pre-camp and at followup) using one between subjects factor (HbA_1c control group) and one within subjects factor (Time). Results demonstrated a between subjects effect of HbA_1c control group, $F(2,58)=61.75$, $p < .0001$, and a Time x HbA_1c control group interaction $F(2,58)=4.81$, $p < .0117$, suggesting that not all three HbA_1c control groups were equally stable on the HbA_1c measure at followup. Therefore, repeated measures ANOVA procedures were conducted with each of the HbA_1c control groups separately using one within subjects factor (Time: pre-camp and followup). Results from these analyses indicated that children in good and poor control remained stable, while youngsters in moderate control demonstrated a significant time effect $F(1,26)=11.09$, $p < .0026$. Examination of the mean HbA_1c values pre-camp and at followup for

each of these groups indicated that while the means for the good and poor control groups remained stable (7.45 to 7.80% and 11.36 to 10.72% respectively), the moderate control group experienced a significant decrease going from 9.51% to 8.80%.

To determine if these changes in HbA_1c levels were associated with camp, a repeated measures ANOVA was conducted on the GSP pre- and post-camp measures using one between subjects factor (the HbA_1c control groups) and one within subject factor (Time). The result demonstrated a significant main effect for Time, $F(1,51)=8.31$, $p < .0058$, and a significant between subjects effect of HbA_1c control group, $F(2,51)=7.51$, $p < .0014$) but no HbA_1c control group x Time interaction. These results suggest that the improvements noted in the moderate HbA_1c control group from pre-camp to 3 months post-camp did not appear to be the result of changes associated with the camp experience.

Relationship between Adherence and Diabetic Control

This study explored the relationship between adherence and diabetic control in two ways. First adherence behaviors during camp were employed in hierarchical regression models to predict to post-camp GSP, and adherence behaviors during the 3 months following camp were used in hierarchical regression models to predict to the followup HbA_1c. Second, categorical anlyses, which involve the division of data into logical groupings, were utilized to explore possible

associations between adherence and diabetic control for differing categories of campers (e.g., those in good versus moderate versus poor diabetic control).

Adherence/GSP Relationships

Hierarchical regression analyses

In order to explore possible relationships between adherence behaviors and diabetic control as measured by GSP, it was hypothesized that adherence measures during camp would predict GSP values post-camp. Since pre- and post-camp GSP measures were highly correlated ($r=.78$), pre-camp GSP was entered first ($R^2=.69$). To determine whether simple patient characteristics would predict post-camp glycemic control, age and duration of disease were added to the model. Since no significant increase in the R^2 occurred, age and duration of disease were dropped from subsequent models. Since increases in GSP levels as well as increases in calories consumed were reported for all youngsters during camp, calories consumed was added next to the model. However, no improvement in the model's predictive power occurred. Next, calories consumed before coming to camp was added to control for pre-camp calorie consumption. The addition of pre-camp caloric consumption did not enhance the model's predictive power. Finally, it was hypothesized that calories consumed during camp may affect post-camp GSP at varying levels of pre-camp GSP control. Therefore a model including pre-camp GSP, calories consumed during camp, and the interaction of pre-camp GSP x calories consumed during

camp was tested. This model did not significantly enhance the R^2 above that offered by the original model using pre-camp GSP as the sole predictor variable.

Since the obvious hypothesis that increases in calories consumed at camp was responsible for the post-camp GSP increases was not confirmed, further analyses were conducted to assess whether any of the other adherence measures may have related to post-camp GSP. To do so, the data were combined into adherence factors found by Johnson et al., (1986). However, Johnson et al.'s factors were based on a combination of child and parent report whereas the data in this study were based exclusively on child report. Accordingly, to support the combination of the child report data into factors, it was necessary to determine whether the measures (based on child report) within each of the Johnson, et al. factors were more highly correlated than measures between factors. The intercorrelation matrix of child reported pre-camp adherence measures was examined. The correlations of measures within factors were averaged (excluding the 1.0s) and compared to the average correlation of measures between factors. Results indicated that similar to Johnson et al.'s results, average correlations of measures within factors were larger (ranging from .22 to .96) than the average correlations of measures between factors (ranging from .01 to .21, see Table 14). These results supported the combination of the measures. Therefore, measures were standardized to pre-camp measures and

TABLE 14
Correlations Between Adherence Measures
Within and Between Factors

Factor:	Exercise	Injection	Diet Type	Eat/Test Frequency	Diet Amount
Exercise	.66				
Injection	.02	.22			
Diet Type	.12	.01	.96		
Eat/Test Frequency	-.03	.10	.21	.27	
Diet Amount	-.11	-.06	.01	.01	.27

five factors were created based on the Johnson et al. (1986) model. Factor 1 contained the three exercise measures, Factor 2 was made up of all four injection measures, Factor 3 consisted of measures of diet type (percentage of calories: carbohydrates and percentage calories: fat), Factor 4 contained measures of eating frequency and glucose testing frequency, and Factor 5 included measures of calories consumed and concentrated sweets. A factor score was calculated by averaging the standardized scores of measures loading highly on that factor. It was expected that the average correlation between factors would be low. This was found to be the case (Table 15) with correlations ranging from r=.01 (between the injection factor and the diet type factor) to r=.26 (between the diet type factor and the eating/testing frequency factor). These correlations were considered to support the relative independence of the factors and justify their use in further exploration of the adherence/control issue.

Hierarchical regression analyses were again used to determine whether adherence behaviors during camp would predict post-camp GSP. Therefore, each of the five adherence factors reflecting camp behavior was added separately to the original model which contained the pre-camp GSP measure. None contributed significant additional variance. Next, it was decided to control for adherence behavior before coming to camp. Therefore, adherence before camp and adherence during camp were added to the original

TABLE 15
Average Correlations between Adherence Factors

Factor:	Exercise	Injection	Diet Type	Eat/Test Frequency	Diet Amount
Exercise	1.00				
Injection	.03	1.00			
Diet Type	.14	.01	1.00		
Eat/Test Frequency	-.05	.19	.26	1.00	
Diet Amount	-.16	-.14	-.02	.03	1.00

model. For example, the model controlling for exercise behavior before coming to camp included pre-camp GSP, exercise factor (before camp) and exercise factor (during camp). None of these five models significantly enhanced the predictive power of the pre-camp GSP prediction model.

Finally, it was hypothesized that insulin dosage during camp might predict post-camp glycemic control. Repeated measures ANOVA on the pre- and during-camp insulin dosage with one within subject factor (Time) indicated that there was a significant difference between dosage before camp compared to dosage during camp $F(1,57)=6.31$, $p < .01$. The average dose before camp was 32.2 units while the average dose during camp was 27.2 units. Adding insulin dosage during camp to pre-camp GSP did not increase the variance accounted for by pre-camp GSP alone. A model which included pre-camp GSP, dosage during camp, and insulin dosage before camp was also tested. No significant increase in the R^2 was achieved. To determine whether children entering camp at different levels of glycemic control would be differentially affected, a model containing pre-camp GSP, insulin dosage during camp, and an interaction of these two measures was tested. This model did not strengthen the predictive power of the original pre-camp GSP prediction model.

Categorical analyses

Categorical analysis involves the division of data into categories based on logical groupings. In this study, the data were grouped based on levels of glycemic control and

levels of adherence as well as change in glycemic control and change in adherence.

Accordingly, it was first hypothesized that children arriving at camp at different levels of diabetic control would report different levels of adherence prior to attending camp. Therefore, based on a univariate procedure on the pre-camp GSP measure, the youngsters were divided into three GSP control categories. Pre-camp GSP of less than or equal to 4.5 was considered good control, greater than 4.5 and less than or equal to 7.0 was considered moderate control, and greater than 7.0 was considered poor control. ANOVAs were conducted on each of the five pre-camp adherence factors using one between subject factor (GSP control group). Results indicated no significant differences between the groups on any of the adherence factors.

Next, it was postulated that the adherence/GSP control relationship might be detected if youngsters were categorized on their degree of adherence before coming to camp. Theoretically, those children who had been more adherent before coming to camp would also exhibit lower GSP values at the beginning of camp. Therefore, based on the pre-camp median score for each of the five adherence factors, youngsters were assigned a score of 1 for being below the median (adherent) and a score of 0 for being above the median (nonadherent). Their scores for the five adherence factors were summed and children were placed into three adherence categories (0-1 was poor adherence, 2-3 was

moderate adherence, and 4-5 was good adherence). An ANOVA was performed on the pre-camp GSP measure using one between subject factor (Adherence group). Results indicated no significant difference between the adherence groups on the pre-camp GSP measure.

It was conjectured that an adherence/control relationship might be better detected if the youngsters were divided into categories of metabolic change. Presumably, those children who exhibited an improvement in diabetic control pre- to post-camp, might show an improvement in adherence behaviors from pre- to during-camp. Such improvement in adherence behaviors would not be expected for children whose diabetic control stayed the same or deteriorated over the camp experience. Consequently, post-camp GSP values were subtracted from the pre-camp GSP values and based on univariate analysis of the resulting difference, the youngsters were divided into children who improved (difference greater or equal to .5), did not change (difference less than .5 and greater or equal to -.4), and got worse (difference less than -.4). A repeated measures ANOVA was conducted on each of the pre- and during-camp adherence factors as well as the calories consumed measure using one between subject factor (GSP difference group) and one within subject factor (Time). Results of these analyses indicated only simple Time main effects for the exercise factor $F(1,59)=155.34$, $p < .0001$, the injection factor $F(1,55)=$

15.51, $p < .0002$, the eating/testing frequency factor $F(1,59)=39.71$, $p < .0001$, and the calories consumed measure $F(1,58)=10.93$, $p < .001$. There was no Time x GSP difference group interaction; youngsters who exhibited differential changes in GSP pre- to post-camp did not exhibit differential changes in adherence pre- to during-camp.

Finally, it was conjectured that changes in adherence might clarify the association between adherence and control. It would seem that children who improved in adherence during camp would exhibit a concomitant improvement in GSP control. while these who did not improve were expected to exhibit stable GSP values pre- to post-camp. Therefore, the children were divided into change groups. Post-camp adherence factors were subtracted from pre-camp adherence factors to produce two groups (those who improved in adherence and those who did not improve in adherence). Repeated measures ANOVA was then performed on the GSP measures using one within subject factor (Time, pre- and post-camp) and one between subject factor (Change group). Results revealed a simple Time main effect. The interaction term was nonsignificant.

Adherence/HbA_1c Relationships

Hierarchical regression analyses

To assess possible relationships between adherence and glycemic control after camp, it was hypothesized that adherence behaviors after camp would predict the followup

HbA_1c. Since pre-camp and followup HbA_1c values were moderately correlated (r=.62), the pre-camp HbA_1c was entered into the hierarchical regression model first (R^2=.39). To determine whether simple patient characteristics would enhance prediction of followup HbA_1c, age was added to this model. Age significantly increased the R^2 to .47 and was retained in all subsequent models. Next, duration of disease was added to this model, but did not enhance the predictive power of the model and was dropped from all subsequent analyses. Further analyses were conducted to assess whether any of the adherence factors were related to followup glycemic control. To do so, the post-camp adherence measures were standardized to the pre-camp adherence measures and combined into the five adherence factors as previously described. Each of the five post-camp adherence factors was then added to the model in five separate regressions. None of the factors contributed significant additional variance. It was conjectured that controlling for adherence before camp might enhance the predictive power of the model. Therefore, each adherence factor pre-camp was added to the model containing pre-camp HbA_1c, age, and the same post-camp adherence factor. The addition of the pre-camp adherence factor did not significantly increase the R^2 in any of the five models tested. It was then postulated that the adherence factors post-camp might predict post-camp HbA_1c for various levels of glycemic control at the outset of the study. Therefore, an

interaction term (adherence factor x pre-camp HbA_1c) was tested for each of the five adherence factors. Only the model that included pre-camp HbA_1c, age, post-camp injection factor, and the pre-camp HbA_1c x post-camp injection factor interaction term proved to increase the R^2 significantly (R^2=.51 see Table 16). The interaction between the pre-camp HbA_1c and injection was interpreted by calculating the nonstandardized Beta weights for injection for varying pre-camp HbA_1c levels from 5.8 to 13.1 (the ranges of pre-camp HbA_1c found in this study's sample) using the equation from Table 16 (as suggested by Cohen and Cohen, 1983). As is apparent from Table 17, injection behaviors in children with low pre-camp HbA_1c (e.g., 5.8 to 7.0) was negatively associated with post-camp HbA_1c: less compliant behavior (higher injection scores) was associated with lower post-camp HbA_1c (i.e., better diabetic control). At pre-camp HbA_1c levels between 8.0 and 9.0 the relationship between injection behavior and post-camp HbA_1c diminishes to zero. For pre-camp HbA_1c levels between 11.0 and 13.1 (poor control) there was a positive association between injection behaviors and post-camp diabetic control, i.e., less adherent behaviors were associated with poorer control. Table 18 depicts the characteristics of three groups divided on the basis of the injection factor Beta weights depicted in Table 17. Noteworthy was a relatively large increase in insulin dosage for both groups where the Injection Beta weights were large (good and poor control youngsters). Due

TABLE 16
Predicting Post-camp HbA_1c by Pre-camp HbA_1c, Age, Post-camp Injection Factor, and Pre-camp HbA_1c x Post-camp Injection Interaction

Variables in model	Beta weights	p<	R^2 = .51
Pre-camp HbA_1c	.47445345	.0017	
Age	.28755174	.0142	
Post-camp Injection Factor	-4.07128891	.0510	
Pre-camp HbA_1c x Post-camp Injection Factor	.45447440	.0487	

TABLE 17
Predicting Post-camp HbA_1c:
Nonstandardized Injection
Beta Weights at Varying Levels
of Pre-camp HbA_1c

Levels of Pre-camp HbA_1c	Injection Factor (Post-camp) Beta Weights
5.8	-1.435
7.0	- .890
8.0	- .435
9.0	- .021
10.0	.473
11.0	.928
12.0	1.382
13.1	1.882

* $\hat{Y}$= 1.33 + .47 (Pre-camp HbA_1c) + .29 (Age)
- 4.07 (Post-camp Injection factor)
+ .45 (Pre-camp HbA_1c x Post-camp Injection factor)

TABLE 18
Pre-camp HbA_1c x Post-camp Injection Factor:
Descriptive Characteristics

Pre-camp HbA_1c Injection B Wts	5.8-7.0 -1.4 to -.9	8.0-10.0 -.4 to .5	11.0-13.0 .9 to 1.9
N	8	37	5
Pre-camp HbA_1c	6.5	8.9	11.6
Post-camp HbA_1c	7.4	8.5	11.0
Age	9.9	10.5	11.2
Duration of disease	3.8	4.0	3.5
Injection factor pre-camp	.10	.01	- .18
Injection factor post-camp	.20	.34	.59
Insulin dose pre-camp	25.9	30.9	33.0
Insulin dose during camp	21.8	27.9	29.4
Insulin dose at followup	34.5	29.5	40.7
Change in insulin dose between pre-camp and followup	8.6	- 1.4	7.7

to this finding it seemed appropriate to consider whether insulin dosage and change in insulin dose would enhance the predictive power of the model that contained pre-camp HbA_1c and age. Insulin dosage at camp did not increase the R^2. To control for pre-camp insulin dose, dosage before camp was added to the model with no increase in R^2. Keeping in mind the role of injection which had earlier been established, it was added to the model. No significant increase of R^2 resulted. It was then hypothesized that the changes in injection behavior at various changes in insulin dose from pre-camp to followup might differentially predict post-camp HbA_1c. Change in insulin dosage was calculated by subtracting the total insulin dosage reported by the child on the last interview (3 months post-camp) from total dosage reported by the child during the last interview before coming to camp. A model including pre-camp HbA_1c, age, difference in dosage, injection factor, and difference in dosage x injection factor interaction term was tested. This model significantly increased the variance, $R^2=.57$ (see Table 19). This interaction was interpreted by calculating the nonstandardized Beta weights for injection for various units of change in dosage from -40 to +40 (the range of total units change found in this study's sample) based on the equation from Table 19. As is apparent from Table 20, the greater the decrease in insulin dose, the higher the injection factor Beta weight. At the insulin dose change of -5 to +10 the relationship between injection and post-camp

TABLE 19
Predicting Post-camp HbA_1c by
Pre-camp HbA_1c, Age, Insulin Dose Change,
Post-camp Injection Factor, and
Insulin Dose Change x Post-camp Injection Interaction

Variables in model	Beta weights	p<	R^2 = .57
Pre-camp HbA_1c	.63400558	.0001	
Age	.24956679	.0321	
Change in insulin dose from pre-camp to followup	.02784116	.0212	
Post-camp Injection factor	.21885475	.4495	
Change in insulin x Post-camp Injection factor	- .06829848	.0065	

TABLE 20
Predicting Post-camp HbA_1c:
Nonstandardized Injection
Beta Weights at Varying Levels
of Change in Insulin Dose from
Pre-camp to 3 Months Post-camp

Levels of Change in Insulin Dose from Pre-camp to Followup	Injection Factor (Post-camp) Beta Weights
-40	2.951
-30	2.268
-20	1.585
-10	.901
- 5	.560
0	.219
5	- .123
10	- .464
15	- .806
20	- 1.147
30	- 1.830
40	- 2.513

* $\hat{Y}$= .26 + .63 (Pre-camp HbA_1c) + .25 (Age) + .03 (Insulin Dose Change) + .22 (Post-camp Injection Factor) - .07 (Insulin Dose Change x Post-camp Injection Factor)

HbA_1c approached zero. Increases in insulin dose were associated negatively with the injection factor Beta weight. Table 21 depicts the characteristics of groups divided based on the Beta weights for injection at varying levels of change in insulin dose (Group 1 decreased insulin, Group 2 stayed the same, and Group 3 increased insulin dose). A number of characteristics are noteworthy for the group of children who reported the largest increases in insulin dose during camp: children in this group were in the best HbA_1c control before camp; this group was the youngest of the three groups; children in this group reported the greatest post-camp compliance; this group was the only one that experienced an increase in HbA_1c while the other two groups demonstrated slight improvement in glycemic control at followup.

The other four adherence factors were considered in similar models to determine if their interaction with insulin dose change would offer similar predictive power. This was not the case.

Categorical analyses

Based on a univariate procedure, the pre-camp HbA_1c values were divided into control categories (less than 8.4=good, greater than 8.4 and less than 10.4=moderate, and greater than 10.4=poor control). ANOVAs were conducted on each of the five adherence factors using one between subject factor (HbA_1c control group). A group effect was detected for the injection factor with the differences between the

TABLE 21
Pre- Post-camp Change in Insulin Dose x Post-camp Injection Factor: Descriptive Characteristics

Change in Dose(CH) Injection B Wts	Ch <= -10 3.0 to .9	-10 < Ch < 15 .6 to -.5	Ch => 15 -.8 to -.2.5
N	13	28	9
Pre-camp HbA_1c	9.3	8.7	8.1
Post-camp HbA_1c	9.0	8.5	8.5
Age	10.6	10.7	9.9
Duration of disease	3.5	4.2	4.5
Injection factor pre-camp	- .14	.18	- .14
Injection factor post-camp	.40	.47	.21
Insulin dose pre-camp	44.1	29.6	13.3
Insulin dose during camp	25.5	30.3	24.4
Insulin dose at followup	21.2	32.4	42.6
Change in insulin dose between pre-camp and followup	-23.7	2.8	29.3

good and poor control groups $F(2,57)=3.75$, $p < .03$. However, the group effect was in the opposite direction of what was expected. That is, the good control group was actually less adherent on the injection factor (.28) than the poor control group (-.24).

The youngsters were then divided into control groups based on a univariate procedure on the followup HbA_1c (less than 8.4=good, greater than 8.4 and less than or equal to 10.4 moderate, and greater than 10.4=poor). ANOVAS on the adherence post-camp adherence factors using one between subject factor (followup HbA_1c control group) revealed no differences. In other words, the pre-camp findings were not replicated with the post-camp data.

Next, the adherence/control relationship was examined by assessing whether control was associated with degrees of adherence. Based on the median score on each of the five adherence factors, youngsters were assigned a score of 1 for being below the median of the pre-camp adherence factor (adherent) and a score of 0 for being above the median of the pre-camp adherence factor (nonadherent). Their scores for the five adherence factors were summed and children were paced into three adherence categories (0-1 was poor adherence, 2-3 was moderate adherence, and 4-5 was good adherence). Separate ANOVA procedures using one between subject factor (Adherence group) on the pre-camp and the followup HbA_1c measures revealed that these groups did not

differ in glycemic control either before camp or at followup.

Next, the HbA_1c measure at followup was subtracted from the pre-camp HbA_1c measure. It was hypothesized that youngsters who exhibited a decrease in HbA_1c at followup would have demonstrated increased compliance, while those whose HbA_1c values increased would have demonstrated decreased compliance. This difference score was subjected to a univariate procedure so that youngsters could be divided into three categories. Scores greater than or equal to .5 were placed in the improved group, scores between .4 and -.4 were in the no change group, and scores less than or equal to -.5 were in the worse group. Repeated measures ANOVA on the adherence factors (based on the three interviews conducted before camp and on the nine interviews conducted during the 3 month followup period) using one within subject factor (Time) and one between subject factor (HbA_1c control category) was conducted. Results indicated a simple Time main effect for the injection factor $F(1,58)= 13.15$, $p < .0006$ and a simple Time main effect for the eating/testing frequency factor $F(1,59)=5.11$, $p < .03$. No Time x HbA_1c change group interaction was detected.

Finally, post-camp adherence factor scores were subtracted from pre-camp adherence factor scores and the children were divided into change groups (improved adherence and less adherent during followup). It was hypothesized that improved adherence would be inversely related to the

post-camp HbA_1c while decreased adherence would be associated with increased HbA_1c at followup. Repeated measures ANOVA was then conducted on the two HbA_1c measures using one within subject factor (Time, pre-camp and followup) and one between subject factor (Change group). Results revealed only a Time main effect.

DISCUSSION

This study was designed to address the following questions: 1) does attendance at a diabetes summer camp alter children's diabetes management behaviors, 2) does attendance at a diabetes summer camp influence children's glycemic control, 3) if there are behavioral or metabolic changes associated with camp, are they maintained once the children return home, 4) is there a relationship between adherence behavior and diabetic control. Results relevant to each of these four questions will first be discussed. A summary of the findings and a discussion of the study's limitations and implications of its results will follow.

Reliability of Child Report

In order to address this question, youngsters and their parents were interviewed prior to and after attendance at a diabetes summer camp. While at camp, counselor report was expected to corroborate and compliment the children's reports. However, when counselor report was found to be unusable, the reliability of the youngsters' self-report had to be established in order to gauge whether any changes in diabetes management behaviors occurred at camp. The results of this portion of the study replicated the findings of Johnson et. al., 1986. Based on Pearson product moment

correlations of parent and child report before and after camp (4 different time periods), it was decided that the youngsters' report was generally reliable concerning diabetes management behaviors.

Agreement was also assessed for three age groups (7- to 9-year olds, 10- to 11.4-year olds, and 11.5- to 12.6-year olds). It was noted that only on 5 of the 13 adherence measures (injection interval, injection-meal timing, calories consumed, exercise duration, and glucose testing frequency) were there significant differences among the age groups. Of these, three of the measures dealt with time and were more problematic for the youngest age groups. These findings are consistent with the findings of Johnson et al., 1986) who found that 6- to 9-year olds showed poor agreement with parent report with measures involving time. This finding was attributed to the difficulty this age group usually experiences with complex mathematical concepts such as time. On the calories consumed measures the oldest children were most concordant while the youngest were the least concordant. This finding is not consistent with the findings of Johnson et al., (1986) and could represent a sample selection bias. On the glucose testing frequency measure, all groups were highly concordant with their parents. Therefore, the significant differences between the two older groups is of questionable clinical significance.

The data were collapsed across age groups so that correlations at the four time periods could be compared.

Results suggested that parent/child agreement was stable across time for 8 of the 13 adherence measures: calories consumed; percent calories: fat; percent calories: carbohydrates; eating frequency; exercise duration; exercise type; exercise frequency; and testing frequency. Significant differences between at least two of the time periods existed on measures of injection regularity, injection-meal timing, regularity of injection-meal timing, and concentrated sweets. Although 3 of the 5 correlations were at their best at Time 5, there was no evidence for a linear improvement with the possible exception of injection-meal timing. However, only 3 of the 13 parent/child correlations (all dealing with the dietary measures) were at their weakest at Time 5 while 8 of the 13 correlations were at their best at Time 5. The relatively better concordance between parents and children at followup could not be attributed to a practice effect since a linear improvement in the correlations was not noted. Rather, this effect may be due to the fact that by Time 5, children were back in school. As a consequence, parents may have been more knowledgeable about their activities but not as aware of what they were eating, since many children eat school lunches. Overall, when considering the parent/child correlations there was no evidence to suggest that information provided by the children deteriorated over the study period.

In addition, differences between child and parent report on the 13 adherence measures were analyzed using repeated measures ANOVA using two between subject factor (Age group, Sex) and one within subject factor (Respondent). Results demonstrated that there were few significant differences between parent and child report. Differences that were detected indicated that on measures of exercise type and frequency, parents' and daughters' reports differed in that girls reported themselves as being more compliant than their parents did. No such difference was detected for boys. In addition parents reported their sons as being more compliant than their daughters while there was no significant difference between girls' and boys' reports on these measures. There were differences between parent and child report on measures of injection-meal timing, eating frequency, and calories consumed. However in all instances these differences were of questionable clinical significance.

Since the children's reports were significantly correlated with parent report both across time and across age groups it was felt that their reports were sufficiently reliable to be utilized in assessing diabetes relevant adherence behaviors before, during, and after camp.

Effect of Diabetes Camp on Adherence

It was expected that compliance would increase at camp since daily schedules revolved around six fixed exercise

periods, three meals and three snacks, and prescribed times for injections and testing per day. Repeated measures ANOVA on each of the 13 adherence measures confirmed that 9 of the 13 were significantly different while the children attended diabetes summer camp, particularly for those behaviors that were regimented or scheduled by camp personnel. Therefore, based on the children's report, diabetes management behaviors of injection regularity, injection-meal timing, calories consumed, eating frequency, exercise duration, exercise type, exercise frequency, and testing frequency were significantly different while the youngsters attended camp. With the exception of calories consumed, children were most adherent during camp. During camp, all children consumed more than the suggested amount and significantly more than at home. After camp all groups returned to pre-camp levels. Although children appeared to be more nonadherent on this measure during camp, increases in dietary intake may be considered appropriate given the significant increase in the youngsters' daily exercise. It is interesting to note that proportions of carbohydrates and fat to total calories and concentrated sweets remained stable before, during, and after camp. This is presumably due to the fact that the children were given free reign during camp meals regarding quantity and selection of foods and most likely selected the types of foods consistent with their home diet, only in greater quantity.

Changes noted in this study are consistent with the only other study published that we were able to locate, that attempted to look at effects of camp on behavior change (Stunkard and Pestka (1962). Stunkard and Pestka monitored the physical activity of 15 nondiabetic obese 10- to 13-year old girls and compared them to matched non-obese nondiabetic girls during and after a 2-week Girl Scout camp. Physical activity was measured by means of a mechanical pedometer and a significantly higher rate of activity at camp was noted for both obese and nonobese girls. However, our study represents a significant expansion of the Stunkard and Pestka (1962) study. In this study, physical activity included measures of frequency of participation, duration of exercise episodes, and type of exercise as gauged by the amount of kilocalories expended per minute. Moreover, multiple other diabetes management behaviors were measured.

Of the three adherence measures (injection interval, calories consumed, and exercise frequency) that demonstrated a significant Time x Age group interaction only injection interval demonstrated a differential effect of camp on older versus younger children. That is, unlike the other eight measures where children of all ages significantly changed at camp, only the oldest group reported improvement at camp on the injection interval measure. It is possible that this result reflects the fact that the younger children's difficulty with time related events was compounded by the fact that during camp, events were scheduled by 'periods'

rather than actual time. In addition, younger children were probably more closely supervised while at home and in that respect, camp did not represent a significant change. Moreover, close scrutiny of the data provided by the 10- to 11.4-year olds revealed that the mean injection interval of 63.30 minutes was the result of several youngsters' inaccurate report of injection times. In any case it is likely that the younger children's adherence on the injection interval measure at camp was underestimated in this study.

Overall, the camp experience was highly consistent for all youngsters regardless of age and sex. It is possible that camp could have had a differential effect on older children. However, this study sample was comprised of a relatively young sample so that age differences demonstrated in other studies which include adolescent samples were not found in this study (Johnson, 1984).

Although it is clear that changes occurred during camp for 9 of the 13 adherence behaviors, it is apparent these changes were not maintained after camp. It appears that the environment, whether it be camp or home, exerts a powerful influence on children's daily diabetes management behaviors. While children may practice more adherent behaviors during camp, these behaviors have not yet become habitual and the child's home environment does not offer the necessary structure to continue these gains once the camp experience is over.

Effect of Diabetes Camp on Glycemic Control

Repeated measures ANOVA on glycosylated serum proteins (GSP) collected at the beginning and at the end of camp indicated that GSP levels were significantly changed over the 2-week camp period. Post-camp GSP values were significantly higher than pre-camp values, indicating that the youngsters were in poorer diabetic control at the end of camp compared to the beginning. This finding was not consistent with the finding of Strickland, et al.,(1984) who reported that GSP values decreased over a 2 week camp experience. However, Strickland et al., used a smaller sample with a larger age range (thirty-six 7- to 15-year olds), did not report how many children were in each age group and did not provide details of the camp experience. Although the improvement in GSP reported in their study was significant, it was small in actual value (decreasing from .83 to .77%). It is conceivable that participants' characteristics were different in the two studies, that the camp experiences were not equivalent, or that camp has no consistent effect on GSP. Since there are so few studies on this topic, it is difficult to ascertain the possible causes of these differing results.

Older campers (11.5 to 12.6 years) had the highest mean GSP values throughout the study. This may be due to the fact that this group was entering puberty. In a recent study Amiel et al., (1986) demonstrated that puberty was associated with increased insulin resistance in normal as

well as diabetic youngsters. Of course, this increased insulin resistance had the most profound effect on diabetic youngsters in whom hyperglycemia is likely to result.

To assess long term effects of the camp experience on glycemic control, a repeated measures ANOVA of the glycosylated hemoglobins (HbA_1c) collected at the beginning and at the end of the study (3 months after camp) was conducted. No significant differences were noted, suggesting that camp effects were not maintained over a 3 month period. That is, the increases in glycemic control noted at the end of camp (increased GSP) were not noted in the followup HbA_1c which remained essentially the same. These findings are consistent with the correlations between the glycemic control measures (between the beginning of camp and at 3 month followup) which suggested moderate stability, and with the data on adherence measures which also demonstrated marked stability within the home environment.

To assess whether children at different levels of glycemic control at the beginning of camp would exhibit different effects, the children were grouped into HbA_1c control categories (good, moderate,and poor). Repeated measures ANOVA revealed that although children in good and poor control at the beginning of this study remained stable over the study period, youngsters in moderate control were significantly improved at followup. However, subsequent analyses suggested that this improvement did not appear to be the result of the camp experience.

Relationship Between Adherence and Diabetic Control

Since this study clearly documented that children were generally more adherent while they were at camp except for calories consumed, hierarchical regressions were used to test the hypothesis that higher post-camp GSP levels were a reflection of significant increases in caloric intake during camp by all youngsters. This hypothesis was not confirmed. It should be kept in mind that although the significant increase in caloric intake could be construed as noncompliance, there was a concomitant increase in exercise behaviors probably necessitating increased food intake. A series of hierarchical regression models was unable to establish a relationship between any of the adherence behaviors and glycemic control during a 2 week camp experience. Rather, the best predictor of post-camp GSP was the pre-camp GSP (R^2=.69). The pre-camp/post-camp GSP correlation was exceptionally high, (r=.83) which we suspect is close to the level of reliability of the GSP measure. If so, there would be little room for other factors to enhance this prediction model. It is possible that the camp experience was too brief and too consistent (everybody changed significantly at camp) to provide sufficient variability to accurately test adherence/control relationships using multiple regression. If so, the association between adherence and control could be better tested using categorical analyses. However, when children were divided into pre-camp GSP control categories, no significant differences in

pre-camp adherence was detected among these groups. Similarly, when children were grouped based on change in glycemic control no differential change in adherence by group was detected. When children were categorized based on their level of adherence before coming to camp, it was found that the GSP levels of the highly adherent children did not differ from the GSP levels of nonadherent children. Similarly, analyses based on groups that either improved or declined in adherence during camp did not reveal any associations between adherence and glycemic control.

To evaluate the relationship between adherence and control after camp, the adherence measures derived from the nine interviews conducted after camp were combined into the five adherence factors. Hierarchical regression analyses revealed that the model that best predicted the followup HbA_1c measure of glycemic control contained the pre-camp HbA_1c, age, (increasing age has been associated with changes in insulin absorption, Amiel et al., 1986), insulin dose differences (pre-camp minus during-camp dose), post-camp injection factor, and an insulin dose difference x post-camp injection factor interaction term (to control for insulin dose changes). When the children were divided into groups based on the Beta weights for the post-camp injection factor for varying levels of insulin dose change pre- to post-camp, it was found that the children who had the largest increase in insulin dose at followup had arrived at camp in the best control, were the youngest (and possibly

not prone to pubertal effects), were most adherent post-camp, had their insulin increased during camp (a trend which was continued after camp), and had experienced an increase in glycemic levels while the other two groups decreased (see Table 21). This finding suggests that this group of youngsters may have experienced increases in HbA_1c due to what is known as rebound hyperglycemia or the Somogyi phenomenon. This phenomenon is thought to be precipitated by overinsulinization which initially causes glycemic levels to drop and then rebound to higher levels (Travis, et al., 1987). Physicians often respond to the "highs" and prescribe even more insulin. It is noteworthy that physicians used the camp physicians as models and continued whatever dose changes that had been made at camp. However, for those youngsters whose insulin was increased at camp, substantial additional increases in insulin dose were made after camp so that by 3 months post-camp their dose had tripled (from an average of 13.3 units before camp to 42.6 units at followup). It is possible that physicians caring for these youngsters responded to their bouts of hyperglycemia by prescribing increased insulin doses i.e., they failed to detect possible rebound hyperglycemia in their children. This hypothesis was further supported by the fact that this group of children were in the best control at the outset of this study and given their age, were not likely to be prone to adolescent related increases in glycemic control. Nevertheless, this was the only group that demonstrated an

increase in HbA_1c by followup. It is possible that increased compliance in this instance (these were the most compliant youngsters) would exacerbate the rebound cycle, leading to deterioration in glycemic control.

When youngsters were categorized into control categories based on pre-camp HbA_1c values, it was found that there was a negative relationship between control and injection factor adherence. However, these results were not replicated post-camp or pre-camp using GSP control groupings. Overall, there was no support for a simple linear associations between adherence and glycemic control at any point in this investigation. These findings are consistent with those reported by Glasgow et al, (1987) who could find no clear relationship between adherence and glycemic control through either bivariate or multivariate analyses.

Limitations and Future Directions

This study had several strengths and limitations. The use of child report made it possible to monitor children over a relatively extensive period of time spanning a naturalistic imposition of behavior change relevant to diabetes management. The advent of GSP measures made it possible to assess diabetic control over a relatively short period of time so that an association between behavior change and glycemic control could be examined. However, the narrow age range in this sample and the consistent change produced by the camp experience did not afford enough

variability to establish clear relationships between adherence and control. The use of a control group in replicating this study might enhance variability, making it possible to better examine adherence/control relationships.

The major implication of this study is that individual differences need closer scrutiny in the area of juvenile diabetes. To date, diabetic regimen recommendations are formulistic and assume that control is a consistent construct that requires consistent behaviors by all youngsters. Future research using multiple baseline design and varying adherence behaviors one at a time under controlled conditions could possibly provide more information concerning highly individualized relationships between adherence and glycemic control. It is possible that children' biological differences require more individual prescriptions. A recent study conducted by Freund et al., (1986) suggests that individual differences exist in symptom patterns of hyperglycemic and hypoglycemic reactions. It is likely that these differences extend into other biological reactions to regimen components such as injection-meal timing, exercise, and dietary intake. Adjustments to insulin dose made during camp are made in response to changes in the camper's routine (most children reported significant changes in behavior during camp). This study clearly demonstrated that once children return home their adherence behaviors revert back to pre-camp levels. It stands to reason that insulin requirements would then need to be readjusted to previous

levels. However, our data indicate that the physicians caring for these youngsters at home tend to use camp insulin changes as a model. This is understandable, since camp physicians are usually pediatric endocrinologists while physicians caring for these youngsters are pediatricians who rarely have specialty training in diabetes. Therefore, physicians at camp should take care to make recommendations which would alert the pediatricians to this potential problem. Insulin dose is at the crux of the diabetes management since it has a powerful influence on control. It is clear that if the insulin dose is not appropriate high levels of adherence will cause worse control. It is possible that some youngsters are not on the correct dose which clearly presents a problem. This situation would account for a curvilinear relationship between adherence with injection behaviors and glycemic control.

It is noteworthy that the only effect of camp that was maintained during the 3 month followup period was insulin dose change. That is, the children's behaviors reverted to pre-camp levels as did their overall glycemic control. However, insulin dose changes initiated at camp were usually maintained and even embellished once the children returned home. It is therefore vital that camp physicians carefully scrutinize their decision process in determining appropriate insulin dose and that they diligently make recommendations for insulin dose adjustment for physicians to follow once the children return home.

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APPENDIX

INTERVIEWER'S NAME: _____

Name: _____ For: _____

Today's date: _____

For: Weekday _____ Weekend _____

INSULIN INJECTION(S)

How many shots prescribed: 1 2 3 4

Time	AM		Time	AM		Time	PM		Time	PM	
	Units	Type		Units	Type		Units	Type		Units	Type
Dose	___	Regular	Dose	___	Regular	Dose	___	Regular	Dose	___	Regular
	___	NPH		___	NPH		___	NPH		___	NPH
	___	Lente		___	Lente		___	Lente		___	Lente
	___	Semi		___	Semi		___	Semi		___	Semi
	___	Actrapid		___	Actrapid		___	Actrapid		___	Actrapid
	___	Monotard		___	Monotard		___	Monotard		___	Monotard
	___	_____		___	_____		___	_____		___	_____
	___	_____		___	_____		___	_____		___	_____
Who gave shot?		_____	Who gave shot?		_____	Who gave shot?		_____	Who gave shot?		_____
This parent obs?	Yes	No	This parent obs?	Yes	No	This parent obs?	Yes	No	This parent obs?	Yes	No

TESTING

	Pre-Breakfast
Method used:	2-drop/cs/other
Tester:	
Parent observed?	Yes No
Time:	AM PM
Sugar:	<2% 2-6% >6%
Ketones:	N S M L
Chemstrip:	

	Pre-Lunch
Method used:	2-drop/cs/other
Tester:	
Parent observed?	Yes No
Time:	AM PM
Sugar:	<2% 2-6% >6%
Ketones:	N S M L
Chemstrip:	

	Pre-Supper
Method used:	2-drop/cs/other
Tester:	
Parent observed?	Yes No
Time:	AM PM
Sugar:	<2% 2-6% >6%
Ketones:	N S M L
Chemstrip:	

	Pre-Bed
Method used:	2-drop/cs/other
Tester:	
Parent observed:	Yes No
Time:	AM PM
Sugar:	<2% 2-6% >6%
Ketones:	N S M L
Chemstrip:	

Method used:	2-drop/cs/other
Tester:	
Parent observed?	Yes No
Time:	AM PM
Sugar:	2% 2-6% 6%
Ketones:	N S M L
Chemstrip:	

FOOD INTAKE

BREAKFAST		SNACK		LUNCH		SNACK		SUPPER		SNACK	
Time AM PM		Time AM PM		Time AM PM		Time AM PM		Time AM PM		Time AM PM	
Parent Obs? Yes No		Parent Obs? Yes No		Parent Obs? Yes No		Parent Obs? Yes No		Parent Obs? Yes No		Parent Obs? Yes No	
Qty/ Size	Item	Qty/ Size	Item	Qty/ Size	Item	Qty/ Size	Item	Qty/ Size	Item	Qty/ Size	Item

EXERCISE

Morning		Afternoon		Evening	
Time AM PM		Time AM PM		Time AM PM	
This parent obs? Yes No		This parent obs? Yes No		This parent obs? Yes No	
Activities	How long?	Activities	How long?	Activities	How long?
Time AM PM		Time AM PM		Time AM PM	
This parent obs? Yes No		This parent obs? Yes No		This parent obs? Yes No	
Activities	How long?	Activities	How long?	Activities	How long?

COMMENTS

Was this a typical day for you? (i.e., eating, exercise, illness, stress, etc.) Yes No
Why?

EXTRA SNACK

Time AM PM	
Parent Obs? Yes No	
Qty/ Size	Item

BIOGRAPHICAL SKETCH

Born in Budapest, Hungary, on February 20, 1944, Marika E. Spevack (nee Kessler) and her family emigrated to Montreal, Canada, where she grew up and married. After 10 years of travel and the advent of 4 daughters, she decided to pursue a degree in education and earned a Master of Education degree from the University of Florida in 1980. After a brief teaching experience, Marika became involved in psychological research and was encouraged by her family and inspired by her employer and mentor to pursue an advanced degree in clinical psychology. From 1982-1987, Marika attended the University of Florida's graduate program in clinical psychology where she earned her M.S. in May 1985. She plans to complete the requirements in time to graduate with a Ph.D. in December 1987.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Suzanne B. Johnson, Chairman
Professor of Clinical and
Health Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Nathan W. Perry
Professor of Clinical and
Health Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Sheila M. Eyberg
Professor of Clinical &
Health Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Jonathen Shuster
Professor of Statistics

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

William J. Riley M.D.
William J. Riley
Associate Professor of
Pathology

This dissertation was submitted to the Graduate Faculty of the College of Health Related Professions and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

December 1987

Dean, College of Health
Related Professions

Dean, Graduate School